THURSDAY, MAY 11, 1876

THE LOAN COLLECTION

THE Queen will on Saturday open to the public the magnificent collection of scientific instruments, the arrangement of which has for several months been tasking the energies of the Science and Art Department and of the eminent men of science who have generously volunteered their assistance. This event may justly be regarded as an "epoch-making" stage in the progress of science, not only in this country, but in the world at large; for, as our readers know, the collection is essentially an international one, the principal nations of the world having vied with each other in contributing to render it worthily representative of the present state of science, and of the progress of its methods from the time when man first began feebly to question Nature. England may well be proud that the idea of such a collection originated with the English Science Department, and that the first international scientific loan collection will be exhibited in her capital. It may be that this collection will not attract such a crowd of visitors as would flock to gaze on an exhibition of pictures, or musical instruments, or embroidery, or old china; but, if the British public still retains its normal amount of curiosity, surely the magnitude of the present collection, the historical interest attaching to many of the objects exhibited, the number and eminence of the contributors, and the fact that the principal governments of Europe have enthusiastically seconded the efforts of the British Government, ought to excite that curiosity to the utmost. A great deal of mystery still hangs about science and scientific men and scientific methods in the eyes of many; here then at last have people an opportunity of inspecting for themselves these mysterious instruments by means of which men of science have reached those results that are stirring the minds of all thoughtful men, and have revolutionised ideas and methods in all departments of human activity. Englishmen must be duller and more incurious than we take them to be, if they do not show a fair amount of interest in that scientific collection which her Majesty will open on Saturday.

But while many, no doubt, will be attracted to the galleries of the International Collection by mere curiosity, we are sure that the scientific education of this country is sufficiently advanced to secure a large proportion of visitors animated by an intelligent and educated eagerness to gratify their scientific tastes by inspecting apparatus the importance and uses of which they are well enough taught to appreciate. Both to this latter class and to those who still lie in unscientific darkness, the two thick volumes[1] which have been issued—prepared at the request of the Lords of the Committee of Council on Education—as guides to the Loan Collection ought to be a welcome boon. Some idea of the extent of the collection may be obtained from the fact that these two volumes together number nearly 1,000 pages, and they are both at present incomplete. With these in his hands as guides no visitor need go empty away from the collection. A careful perusal of these two volumes combined with a systematic series of visits to the various sections of the collection, would, like the acquaintance of a certain noble lady, be in itself a liberal education; and indeed few better methods could be devised of rousing a love for science in the minds of intelligent people.

In two previous articles we have attempted to give a general sketch of the nature of the collection; in the present article we shall, with the two volumes referred to as guides, briefly give some idea of its extent and arrangement. The large Committee—and there is scarcely a scientific name of eminence absent from it—that met little more than a year ago at the request of the Lords of the Committee of Council on Education to confer on the organisation of a Loan Collection of Scientific Apparatus ought to be proud of the results of that first conference as embodied in these two valuable publications. The names on this Committee, and those on the Committees formed in foreign countries, number somewhere about 300; a glance at the lists shows that the names are those of the foremost scientific workers of our time. Specially gratifying must the result be to the staff of volunteers who have assisted in the arrangement of the collection, and whose names their Lordships justly record with "great satisfaction." They are: Capt. Abney, Dr. Atkinson, Mr. Bartlett, Dr. Brunton, Dr. Biedermann, Prof. Crum-Brown, Capt. Fellowes, Prof. Carey-Foster, Dr. Michael Foster, Herr Kirchner, Prof. Goodeve, Dr. Guthrie, Commander J. A. Hull, Mr. Iselin, Mr. Judd, Mr. Norman Lockyer, Dr. R. J. Mann, Mr. Clements Markham, Prof. H. MacLeod, Prof. Roscoe, Prof. Shelley, Dr. Burdon Sanderson, Dr. Schuster, Dr. Voit, and Mr. R. Wylde.

Their Lordships, we should say, are particular in calling attention to the fact that this is not an International *Exhibition;* the purpose and arrangement of this collection are entirely different from those of such an exhibition, which is always arranged according to countries and into which the commercial element largely enters. The arrangement here, on the contrary, is according to subjects, and the object is solely to illustrate the history and present condition of scientific apparatus. The transport of all objects has been undertaken by the English Government, and they have been handed over absolutely to the custody of the Science and Art Department.

Prefixed both to the Catalogue and the Guide is a clear and useful plan of the buildings at Kensington, showing the arrangement of the apparatus in the various galleries. Fourteen galleries in all are occupied with the collection, embracing the ground floors of the entire south and west sides, and the upper floor of the latter. Entering, as the Queen will do on Saturday, by the entrance in Exhibition Road, we come first upon A, the Educational Collections; following which are B, C, Applied Mechanics; D, Naval Architecture and Marine Engineering; E, Lighthouse Apparatus; F, Magnetism and Electricity; G, Arithmetic and Geometry; H, K, Measurement; L, Astronomy and Meteorology; these are all on the ground floor. Ascending to the upper floor, we pass through M, Geography, Geology, and Mining; N, Biology; O,

[1] "Catalogue of the Special Loan Collection of Scientific Apparatus at the South Kensington Museum." First Edition.—"Handbook to the Special Loan Collection of Scientific Apparatus." 1876.

Conference Room; P, Chemistry; Q, Light, Heat, Sound, and Molecular Physics.

The number of exhibitors—governments, societies, departments, and individuals—amounts to about 1,000, and the collection contains altogether somewhere about 15,000 objects, arranged in this first edition of the catalogue, under 4,576 heads. The countries represented are the United Kingdom, Austro-Hungarian Empire, Belgium, France, Germany, Holland, Italy, Norway, Russia, and Switzerland. The list from Spain is not yet received, and the fact that America is occupied with her own Centennial Exhibition sufficiently accounts for her absence, though the American Government heartily sympathises with the object of the collection. In the catalogue the objects are arranged under twenty-one sections; the numbers enable the visitor at once to identify each object or group of objects, and in most cases the appended descriptions are sufficiently detailed to enable anyone to understand the purpose and construction of the apparatus. In many cases the descriptions are as minute as in a special text-book.

Under Section 1, Arithmetic, are described various Slide-rules, 19 in all, 26 Calculating Machines, including Babbage's famous "Difference Engine," which is described in considerable detail, besides some interesting and ingenious miscellaneous apparatus. Under Section 2 are classed instruments used in Geometrical Drawing, Instruments for tracing Special Curves, Models of Figures in Space, and a collection of Plücker's models of certain quartic surfaces, contributed by the Mathematical Society.

As might be expected in a collection of scientific apparatus, those connected with Measurement, Section 3, occupy a large space: there are upwards of 350 entries under this head, comprising, besides a variety of extremely interesting and curious special collections, apparatus for Measurement of Length (nearly 100 entries) of Area, of Volume, of Mass, of Velocity, of Momentum, of Force, of Work, of Angles, and of Time (80 entries); many of the objects in this section are of a remote antiquity, and not a few are connected with scientific discoveries of the highest importance.

Section 4, Kinematics, Statics, and Dynamics, is a very full and instructive one; it is impossible to give here anything like an idea of the nature and variety of the apparatus exhibited under this head. It contains 22 sub-sections and sub-sub-sections, including several of 'sGravesande's apparatus, apparatus illustrating the Mechanical Powers, Pendulums and Gyroscopes, Vibrations and Waves, Falling Bodies and Projectiles, and other departments of the very comprehensive section, including 54 Crank Trains, 50 Toothed-wheel Trains, and 67 Ratchet Trains.

To many, Section 5, Molecular Physics, will be intensely interesting; its six sections contain 110 entries; the Air-pumps and Pneumatic Apparatus alone numbering 44. Osmose Dialysis and Diffusion, Condensation of Liquids and Solids, and Hydrometers, are some of the other subjects illustrated here.

Sections 6, 7, and 8, Sound, Light, and Heat, are of course among the most important, the catalogue containing 410 entries under these heads. There are apparatus illustrating the Sources, Measurement, and Interference of Sound, and a variety of other phenomena, including Musical Sounds; in Section Light, under the head Selectors, there are 36 groups of apparatus connected with the Spectroscope, and 30 to illustrate Polarisers, besides Photometers, Radiometers, apparatus bearing on Reflection, Refraction, and Diffraction. Photography is a varied and interesting sub-section. The multitude of apparatus connected with Heat is classified under Sources of Heat, Thermometry (56 entries), Calorimeters, Pyrometers, Freezing Machines, Conductors, &c.

Sections 9 and 10, Magnetism and Electricity, are likely to prove two of the most attractive, as they are certainly among the most important. All departments of these subjects—and how varied they are even scientific men may be astonished to learn—are illustrated with great fulness; the number of entries in the Catalogue is 650, commencing with the greatest natural magnet yet known, weighing, with armature, 152 kilograms, sent by the Teyler Foundation, Haarlem, and concluding with a minute description of the Polar Light Apparatus, by Prof. Lemström. Of apparatus connected with Electricity the variety is astounding. Friction and Induction Machines, Galvanic Batteries (there are 32), Thermo-Electric Batteries, Induction Coils, Magnetic-Electric Machines, and other modes of producing Electricity or Electric Currents, are abundantly represented. So, also, apparatus for producing, collecting, observing, regulating, and measuring electricity; of Galvanometers alone there are 43. In the Electrical Section, no doubt the most attractive department to the general public will be that devoted to apparatus for the application of Electrical principles to practical purposes, illustrating, as it does, every stage in the progress of the Electric Telegraph. The Catalogue in this department contains 204 entries of Telegraphic apparatus alone, not to mention the various other applications of electricity to military and other purposes.

Astronomy, Section 11, is at the same time one of the oldest and one of the most popular of the sciences, and therefore the apparatus in the section will probably have more than an average number of visitors. The historical interest of this section is probably greater than that of any other, and it is significant of the importance attached by Italy to this Collection that she has parted with, even for a short time, those precious relics of Galileo that cannot fail to excite the veneration of all beholders. But besides these there are many other instruments of great historical interest, from the Suspension Astrolabrum, made in 1525, sent by Prof. Buys Ballot of Utrecht, down to the latest form of spectroscope, and a relief landscape of the moon. Celestial photography is largely represented, both by its instruments and results, and teachers will be much interested in the varied and ingenious apparatus that have been devised for the practical teaching of astronomy.

Of the multitude of objects in Section 12, Applied Mechanics, it would be impossible with our space to give any satisfactory idea. The catalogue contains under this head 470 entries in all, many of which, as indeed is the case in all the other sections, include a considerable number of separate pieces of apparatus. Of Prime Movers alone there are 66 groups, ranging through many forms from a collection of the Original Models of Steam Engines and other machines of James Watt, downwards.

Under the comprehensive head of Application of the Principles of Mechanics to Machinery, as employed in the Arts, the catalogue gives a description of 136 varieties of apparatus, from the first type-composing machine invented by Alex. Mackie, which comes from Dundee, down to the latest forms of link-work.

Chemistry, Section 13, is of course one of the most prominent and important sections in the whole collection. When we say that the catalogue contains 360 entries under this head, we give very little idea of the multitude and variety of objects which have been brought together to illustrate the methods and results of the all-pervading science. The first entry is the apparatus employed by John Dalton in his researches, and is accompanied by a long descriptive and historical notice by Prof. Roscoe. Cavendish, Davy, Faraday ("Original tubes containing gases liquefied by Faraday," must be an exciting entry to many chemists), Wollaston, are names attached to some of the apparatus of historical interest; of Models, Diagrams, Apparatus, &c., employed in teaching Chemistry there is no end, and all the infinite variety of special chemical apparatus is amply illustrated, there being upwards of 200 entries under this head, representing probably more than ten times that number of separate objects.

The rapid advances and present complexity and comprehensiveness of Meteorological science are shown by the catalogue to be illustrated with wonderful fulness in the collection. The endless variety of Barometers, Thermometers, Anemometers, Rain-gauges, Hygrometers, Self-recording Instruments, Ozonometers, and other apparatus used in meteorology, will excite the astonishment of all but specialists. The Scottish Meteorological Society is a large contributor in this section, and some of their intensely practical graphic results must appeal to the blindest utilitarian.

Geography is sure to be a popular section, and we can only say that in its various sub-divisions are objects calculated to rouse the interest of the most incurious. The methods, apparatus, and results of the various surveys of this country and of India are illustrated in the greatest detail, and now that the *Challenger* is nearing our shores, many will be curious to see some of the apparatus with which her important ocean-researches have been conducted. There is a vast variety of surveying apparatus with which Geography obtains her apparently simple results, and of Maps, Charts, and Plans of all kinds the list is endless. Everyone must inspect with very curious feelings the original Journals, Logbooks, &c., kept by celebrated English navigators from Dampier downwards, not to mention the valuable MS. Maps of Livingstone and other celebrated explorers.

Geology, Mining, and Mineralogy, Sections 16 and 17, are well represented. They include Geological Instruments and Apparatus; Maps, Sections, Diagrams, &c., lent by the Geological Survey; illustrations of the Sub-Wealden boring; various Relief-maps and Models illustrating Geological Phenomena all over the world; Fossils and Specimens of all kinds, natural and artificial; Mining Instruments and accessories, including a case of 46 varieties of Safety-lamp; Blowpipe Apparatus; Minerals, Diagrams, Models of Crystals, &c.

The Section of Biology has 500 entries, embracing probably eight times that number of separate objects. Of microscopes and accessory apparatus, there are upwards of 150 from the Compound Microscope of Zacharias Janssen, spectacle-maker, at Middleburg, Netherlands, constructed about 1590, down to the latest and most complicated form of this now indispensable and powerful instrument. Then there are many specimens of the curious and ingenious apparatus employed in Physiological Optics, Weighing and Measuring Apparatus, Apparatus for investigating the functions of Circulation and Respiration, of Muscles and Nerves, and an endless variety of Diagrams, Models, Preparations, and other appliances for instruction in Biology. Wolf's Collection of 106 Original Water-Colour Drawings illustrating the new and rare animals in the Zoological Gardens will prove nearly as attractive as the originals themselves.

Under Educational Appliances, Section 19, there are apparatus for practical instruction in Science in every department, including a very fine and large collection of apparatus for instruction in Physical Science, contributed by the Committee of the Pedagogical Museum, Russia. This section contains upwards of 550 entries.

Last of all comes the Collection of Apparatus and Photographs illustrating Italian Science, more especially in the departments of Physics, Mechanics, and Astronomy. There are many objects here deserving special mention, but our space forbids further detail. We have already referred to Galileo's instruments, and besides these there are many others of great antiquity and of much interest in connection with the progress of scientific apparatus.

This rapid glance at the contents of the Catalogue will give but a faint idea of the rich feast in store for those who during the next few months will be attracted to the South Kensington galleries. To give anything like an adequate idea of the contents of the collection would take a long series of articles.

We have said that the Catalogue, even in its present incomplete and rough form, is something more than a mere list of titles; it is very largely descriptive. But something more was required to show the purpose and import and historical place of the multitude of separate instruments in the various sections. This want is supplied in the admirable Handbook, of 340 pages, consisting of a series of descriptive and historical articles on the various sections by some of the most eminent living British men of science. It will be enough if we give here the names of the authors and the subjects of which they treat. In value the Handbook should be put alongside the Admiralty Manual issued to the Arctic Expedition; though probably no such unique collection of scientific memoirs was ever before put within reach of the public. The first paper is by Prof. Clerk-Maxwell, being "General Considerations respecting Scientific Apparatus;" Prof. Maxwell has also a paper in his own special domain, Molecular Physics. Prof. H. J. S. Smith writes on "Arithmetical Instruments" and "Geometrical Instruments and Models." Prof. W. K. Clifford also contributes two papers, on "Instruments used in Measurements" and on "Instruments illustrating Kinematics, Statics, and Dynamics." Then there are papers by Dr. W. H. Stone, on "Acoustical Instruments," by Mr. W. Spottiswoode on "Optical Instruments," by Capt. Abney on "Photographic Printing Processes," by Prof. Tait on "Instruments employed in Heat Investigations;" two

papers by Prof. Carey Foster on "Magnetic Apparatus" and "Electrical Instruments;" a paper by Mr. J. Norman Lockyer on "Astronomical Instruments;" by Prof. Goodeve on "Applied Mechanics," by Prof. McLeod on "Chemical Apparatus and Products," by Mr. R. H. Scott on "Meteorological Instruments." "Geographical Instruments and Maps" are illustrated historically and descriptively in four papers by Mr. C. R. Markham, and one by Capt. J. E. Davis. Prof. Geikie treats of "Geology," Mr. Warington Smyth of "Apparatus used in Mining," Prof. Story Maskelyne of "Crystallography and Mineralogy," Prof. Huxley of "Instruments employed in Biological Research," and Mr. H. C. Sorby of "Microscopes." Is not this strong enough evidence of the genuine interest which British men of science take in this Loan Collection of Scientific Apparatus?

There is only one drawback to our joy in seeing this collection at last completed and ready to be thrown open to the public: it is after all only a "loan" collection, and in a few months must be disorganised, and the apparatus returned to their owners. We have some reason to hope, however, that this will not be the end of all the labours of the eminent men who have exerted themselves to make the collection a success; we are persuaded that in time it will be succeeded by a permanent collection, which will form a Science Museum on an equal footing with the other Museums supported by Government. The Introduction to the Handbook says:—

"The Lord-President of the Council, the Duke of Richmond, and the Vice-President, Viscount Sandon, in explaining the objects of the collection, took occasion to refer to the recommendations of the Royal Commission on Scientific Instruction, with regard to the creation of a Science Museum. Their Lordships stated their conviction that the development of the Educational and certain other Departments of the South Kensington Museum, and their enlargement into a Museum somewhat of the nature of the Conservatoire des Arts et Métiers in Paris, and other similar institutions on the Continent, would tend to the advancement of science, and be of great service to the industrial progress of this country."

We cannot doubt that neither Government nor the public, after having substantial evidence of the value and important results of a Science Museum in this Loan Collection, will rest satisfied until this country is at least on an equal footing in this respect with our neighbour France. It seems to us that a permanent Science Museum will be the natural outcome of the unexpectedly magnificent collection which the Queen will open on Saturday; it cannot fail to make the public at large conscious of a serious want which for long has been painfully felt by men engaged in scientific research, both pure and applied.

DIFFUSION OF GASES THROUGH ABSORBING SUBSTANCES

Ueber die Diffusion der Gase durch absorbirende Substanzen. Habilitationsschrift der Mathematischen und Naturwissenschaftlichen Facultät der Universität Strassburg, vorgelegt von Dr. Sigmund v. Wroblewski, erstem Assistanten am physikalischen Institute. (Strassburg: G. Fischbach, 1876.)

THE importance of the exact study of the motions of gases, not only as a method of distinguishing one gas from another, but as likely to increase our knowledge of the dynamical theory of gases, was pointed out by Thomas Graham. Graham himself studied the most important phenomena, and distinguished from each other those in which the principal effect is due to different properties of gases.

The motion of large masses of the gas approximates to that of a perfect fluid having the same density and pressure as the gas. This is the case with the motion of a single gas when it flows through a large hole in a thin plate from one vessel into another in which the pressure is less. The result in this case is found to be in accordance with the principles of the dynamics of fluids. This was approximately established by Graham, and the more accurate formula, in which the thermodynamic properties of the gas are taken into account, has been verified by the experiments of Joule and Thomson. (Proc. R. S., May, 1856.)

When the orifice is exceedingly small, it appears from the molecular theory of gases that the total discharge may be calculated by supposing that there are two currents in opposite directions, the quantity flowing in each current being the same as if it had been discharged into a vacuum.

For different gases the volume discharged in a given time, reduced to standard pressure and temperature, is proportional to—

$$\frac{p}{\sqrt{s\theta}}$$

where p is the actual pressure, s is the specific gravity, and θ the temperature reckoned from $-274°$ C.

When the gases in the two vessels are different, each gas is discharged according to this law independently of the other.

These phenomena, however, can be observed only when the thickness of the plate and the diameter of the aperture are very small.

When this is the case, the distance is very small between a point in the first vessel where the mixed gas has a certain composition, and a point in the second vessel where the mixed gas has a quite different composition, so that the velocity of diffusion through the hole between these two points is large compared with the velocity of flow of the mixed gas arising from the difference of the total pressures in the two vessels.

When the hole is of sensible magnitude this distance is larger, because the region of mixed gases extends further from the hole, and the effects of diffusion become completely masked by the effect of the current of the gas in mass, arising from the difference of the total pressures in the two vessels. In this latter case the discharge depends only on the nature of the gas in the vessel of greater pressure, and on the resultant pressures in the two vessels. It consists entirely of the gas of the first vessel, and there is no appreciable counter current of the gas of the other vessel.

Hence the experiments on the double current must be made either through a single very small aperture, as in Graham's first experiment with a glass vessel accidentally cracked, or through a great number of apertures, as in Graham's later experiments with porous septa of plaster of Paris or of plumbago.

With such septa the following phenomena are observed:—

When the gases on the two sides of the septum are

different, but have the same pressure, the reduced volumes of the gases diffused in opposite directions through the septum are inversely as the square roots of their specific gravities.

If one or both of the vessels is of invariable volume, the interchange of gas will cause an inequality of pressure, the pressure becoming greater in the vessel which contains the heavier gas.

If a vessel contains a mixture of gases, the gas diffused from the vessel through a porous septum will contain a larger proportion of the lighter gas, and the proportion of the heavier gas remaining in the vessel will increase during the process.

The rate of flow of a gas through a long capillary tube depends upon the viscosity or internal friction of the gas, a property quite independent of its specific gravity.

The phenomena of diffusion studied by Dr. v. Wroblewski are quite distinct from any of these. The septum through which the gas is observed to pass is apparently quite free from pores, and is indeed quite impervious to certain gases, while it allows others to pass.

It was the opinion of Graham that the substance of the septum is capable of entering into a more or less intimate combination with the substance of the gas; that on the side where the gas has greatest pressure the process of combination is always going on; that at the other side, where the pressure of the gas is smaller, the substance of the gas is always becoming dissociated from that of the septum; while in the interior of the septum those parts which are richer in the substance of the gas are communicating it to those which are poorer.

The rate at which this diffusion takes place depends therefore on the power of the gas to combine with the substance of the septum. Thus if the septum be a film of water or a soap bubble, those gases will pass through it most rapidly, which are most readily absorbed by water, but if the septum be of caoutchouc the order of the gases will be different. The fact discovered by St. Claire-Deville and Troost that certain gases can pass through plates of red hot metals, was explained by Graham in the same manner.

Franz Exner[1] has studied the diffusion of gases through soap bubbles, and finds the rate of diffusion is directly as the absorption-coefficient of the gas, and inversely as the square root of the specific gravity.

Stefan[2] in his first paper on the diffusion of gases has shown that a law of this form is to be expected, but he says that he will not go further into the problem of the motion of gases in absorbing medium, as it ought to form the subject of a separate investigation.

Dr. v. Wroblewski has confined himself to the investigation of the relation between the rate of diffusion and the pressure of the diffusing gas on the two sides of the membrane. The membrane was of caoutchouc, 0·0034 cm. thick. It was almost completely impervious to air. The rate at which carbonic acid diffused through the membrane was proportional to the pressure of that gas, and was independent of the pressure of the air on the other side of the membrane, provided this air was free from carbonic acid. The connection between this result and Henry's law of absorption is pointed out.

[1] "Pogg. Ann.," Bd. 155.
[2] "Ueber das Gleichgewicht u. d. Diffusion von Gasgemengen." Sitzb. er k. Akad. (Wien), Jan. 5, 1871.

The time of diffusion of hydrogen through caoutchouc is 3·6 times that of an equal volume of carbonic acid. The diffusion of a mixture of hydrogen and carbonic acid takes place as if each gas diffused independently of the other at a rate proportional to the part of the pressure which is due to that gas.

We hope that Dr. v. Wroblewski will continue his researches, and make a complete investigation of the phenomena of diffusion through absorbing substances.

J. CLERK MAXWELL

MACALISTER'S "ANIMAL MORPHOLOGY"

An Introduction to Animal Morphology and Systematic Zoology. Part I.—Invertebrata. By Prof. Alexander Macalister, M.B. (Longmans, Green, and Co., 1876.)

HOW many of those who are not of an extra systematic turn of mind, when they review their reading in any special line of research, have continually to regret that they have not had the industry to abstract as well as to classify the various monographs and papers they have perused, and to preserve them in a united form for future reference. Those of us who are zoologists may lay aside some of our misgivings on this score; for one among us, an exhaustive reader and an acute appreciator of the relative importance of facts, has so widely distributed his literary investigations, at the same time that he has made it a principle to keep a memorandum of those points which have most impressed him, that he has felt justified—quite correctly, as all his readers we are convinced will agree—in placing his compilation at the disposal of the scientific public. The volume on the Invertebrata, now before us, fills between four and five hundred closely printed octavo pages.

It is evident that a work constructed on the principles above indicated must be of too exhaustive and too abstruse a nature for the commencing student. It would be impossible for any author so to combine primary definitions and first principles with elaborate detail as to produce a book which would appeal to the tyro as well as the advanced zoologist. Prof. Macalister's "Introduction to Animal Morphology" must be therefore looked upon as an introduction to the science proper, to be read by the second-year student, or to be interleaved for further annotation by the specialist. To teachers of Zoology it will be found invaluable on account of the great fund of information it contains in a highly condensed form, also because in nearly all cases the *name* of the authority for each important fact is associated (in brackets) with his observation. In such a work we think that no better method could have been employed. It would have greatly overloaded the pages if full references had been given; and now that the invaluable Catalogue of Scientific Papers, published by the Royal Society—in which the publications are arranged under the *names* of authors—is within reach of all, in the libraries of the learned societies, if not elsewhere, it is a matter of no great difficulty for anyone who is particularly interested in any special detail, to find which is, and refer to, the monograph or shorter communication in which the point in question is embodied.

There is a small detail in association with the printing of the work, a modification of which in the second volume

would be an immense advantage. Prof. Macalister heads each page with the words, "Introduction to Animal Morphology." In so doing he seems to have entirely overlooked the fact that the object of the heading is to give some notion as to what is to be found below it, and not the title of the work itself. Why he has not followed the ordinary method of placing on the top of one of each two pages the subject of the chapter, and on the other further detail, we are at a loss to understand, and suffer accordingly in attempting to make any particular reference.

The first seven chapters of Prof. Macalister's work are on general subjects: protoplasm, general morphology, histology, tectology (individuality and the formation of organs), reproduction, and the distribution of animals. There are certain statements in the last of these with which we cannot quite agree. That Patagonia should be entirely removed from the Neotropical Region and placed together with the Southern Circumpolar Land in a special Antarctic, seems very much at variance with known facts. Why the Polar Bear should be only mentioned in association with the Nearctic Circumpolar Region; the Aard-vark, Manis, and Manatee with the Guinean; the Catarrhine Monkeys with the Indian; Bennett's Cassowary with the Australian; the Birds of Paradise with the Indo-Malay, we are at a loss to comprehend.

In association with the doctrine of the origin of species we are told that, "as a natural deduction from evolution, we have *Dr. Haughton's* law, that all structures are arranged so as to give the maximum of work possible under the given external conditions." This law is, however, a natural deduction from the theory of natural selection, not from evolution; it not being evolution, *per se*, but the struggle for existence which brings to the foreground the most economical animal machinery. It may also be mentioned that there are still wanting some important links in the chain of reasoning which explains the diminution of organs, like the wings of birds, in small islands. These seem to be lost on account of the reduction of the struggle for existence, mammals not being on the ground to contest the field. Dr. Haughton's law, therefore, no longer applies apparently. Why then are the wings lost?

The classification adopted is that of Haeckel modified, the Metazoa being primarily divided into the two sub-series, Polystomata (Sponges) and Monostomata; the Cœlenterata being removed from the Porifera, and included with the other forms in which there is but one aperture of ingress into the body-cavity. No very special stress is laid on the vertebrate affinities of the Tunicata, which are included in the sub-kingdom Vermes. Of their development we read that "in Ascidia and Phallusia the segmented yelk assumes its mulberry form, hollows within, and appears as a spherical, cellular body (blastula); a groove indents one side of this; the lips of the groove rise and close it in, except in one spot, and thus the body becomes bicavitary, the dorsal groove contracts, and the nerve ganglion develops either within it or in its close vicinity. On a plane between the dorsal neural cavity thus formed and the ventral space, a double row of large cells appears, which extends into the tail, and forms an axis for that organ. These cells resemble those of the chorda dorsalis of Vertebrates, and have a similar relation to the neural and visceral cavities of the primarily bicavitary body to that possessed by the dorsal chord. Upon these phenomena, observed by Kowalewsky, Kupffer, and others, is rested the theory of relationship of Tunicates and Vertebrates, which is strengthened by the setting apart here of a portion of the digestive canal for respiratory purposes." This quotation illustrates the condensed manner in which the whole work is written and the way in which single words are frequently modified to do the duty of whole sentences. As a second illustration of the same method when employed with reference to the sub-kingdom Cœlenterata, one in which name-coining has arrived at a worse pitch even than in systematic botany—the following sentence will suffice:—"The alternation of generations may be binary (hydranth, gonophore, + hydranth, gonophore, &c.), or ternary (hydranth, blastostyle, gonophore, + *h*, *b*, *g*, &c.), or quaternary (hydranth, blastostyle, blastocheme, gonocheme, + *h*, *b*, *b*, *g*, &c.); or even more complex if the hydranths be heteromorphic." The Mollusca are treated of between the Vermes and Arthropoda, it being remarked of them that "their structure can be easily understood by regarding them as Vermes with no articulated appendages, modified by unequal lateral development, and by a fusion of the metameres," although "we know as yet of no absolute passage forms or direct synthetic types." This being the case, we cannot understand how each of these major groups can be regarded as a sub-kingdom.

The author, in his preface, regrets that, owing to the long time that the work (written in 1873) has been going through the press, he has not been able to introduce into it references to recent discoveries, which explains several important omissions. Notwithstanding this, we are convinced that all zoologists will agree that the work is a most valuable addition to the literature of general animal morphology.

OUR BOOK SHELF

Introductory Text-book of Physical Geography. By David Page. Eighth Edition. (Blackwood and Sons, 1876.)

INTRODUCTORY text-books on Physical Geography are not numerous, and if we may judge by the calls for new editions, this one is growing in favour. It certainly gives in a short and handy form the most important facts of the subject—and in the descriptive part it is merely a question of the selection of the most important, and in this respect we think the selection judicious, as indeed it would appear to have been found. Dr. Page comes to Physical Geography from the side of Geology, and his readers reap the benefit of it, in the chapters relating to the structure of the earth, and to the work of rivers, and to the positions of mountain ranges, which are very good. In many other respects too, the book is worthy of the support it receives, the facts being told clearly, concisely, and for the most part truly.

We cannot help, however, drawing attention to one or two points which we think would at least have been differently worded if the author had approached his subject from a physical side in his explanation of phenomena. Thus we are told with reference to water, that "when converted into steam it occupies 1,696 times more space with a specific gravity of only ·622." The only standard of specific gravity mentioned is water at 62° F., and a physicist might ask at what *pressure* is the steam?

Again, we read, "the atmosphere being the medium

through which the sun's heat is conveyed to and from the earth, the lower and denser strata absorb the greatest amount, and are necessarily the warmer;" a sentence of which a teacher would score almost every word. Again, on the subject of dew, we read that "substances like glass, &c., which *rapidly* lose their own heat and *slowly* acquire that of others are susceptible of being copiously bedewed." The italics are ours. And once more, "when the temperature of the air is reduced below that of the invisible vapour it contains, the moisture becomes visible." These extracts could be multiplied till we might wonder if it is really a book on *Physical* Geography we are reading. But these are serious defects, and we wish they could be altered. By the side of them it is of less consequence that while we read in the Preface that "this revision embraces all that is important in recent discovery;" yet on turning to the temperature of the sea, where the most important changes have taken place in our knowledge, we are still referred to Sir James Clarke Ross, and told that the ocean has below the surface a uniform temperature of 39½°, for which at the equator we must descend deeper than anywhere else. We can scarcely imagine that any amount of clearness will atone for these things; let us hope they will be seen to before edition the ninth is required.

The Flora of South Australia. By R. Schomburgk, Ph.D., Director of the Botanic Gardens, Adelaide. (W. C. Cox, 1875.)

WE have here a complete list of the indigenous flora of South Australia, both tropical and extra-tropical, with some general remarks prefixed. The most predominant natural orders in the colony are Leguminosæ, Myrtaceæ, Compositæ, Proteaceæ, Cruciferæ, Rubiaceæ, and Gramineæ. The genera and species are remarkably circumscribed in area; many are found in one spot alone. The colony is singularly devoid of native edible fruits and roots; on the other hand it produces abundance of valuable timber-trees and of plants suitable for the manufacture of paper and other fibres, and for the production of dyes; but most of the valuable crops are naturalised plants, introduced from Europe or other parts of the world.

A. W. B.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

Theory of Electrical Induction

IN NATURE, vol. xiii. pp. 437, 475, Prof. Paul Volpicelli gives an exposition of the two theories of electric induction, containing copious references to the writings of electricians, and numerous experiments of his own. It is remarkable, however, that he has not only omitted all reference to the works of Poisson, Green, Thomson, Beer, Betti, &c., who have studied the mathematical theory of induction, but he has not even introduced the word potential into his exposition, unless we are to take the word tension in the sense of potential, where he says that a certain portion of electricity possesses tension while another portion does not.

The result of this mode of treating the subject without calling in the aid of those ideas and phrases which the progress of science has developed, is to convey the impression that the whole theory of induction of electrification on the surface of conductors is still in a very imperfect and vague condition, whereas there is no part of electrical science in which we can trace more distinctly the correspondence, quantitative as well as qualitative, of the phenomena with the general laws of electricity. It appears, however, from what M. Volpicelli says, that an erroneous theory is still generally adopted in treatises on physics and electricity, and that it ought to be superseded by a more correct theory first proposed by Melloni.

Both theories admit that if an insulated conductor, without charge, is acted on by a charged inductor, the surface becomes electrified, oppositely to the charge of the inductor on the parts nearest the inductor, and similarly to the charge of the inductor on the parts farthest from it. The first of the two theories, however, asserts that both these electricities are "endowed with tension," whereas the second, that of Melloni, asserts that the electricity of the same kind with that of the inductor is alone "endowed with tension," while the other kind of electricity is entirely "latent or dissimulated."

The only sense which we can attach to the word "tension" as thus used, is that which modern writers mean by "potential," or potential function, the difference being that the word tension is often used in a vague manner, whereas potential is strictly defined.

Thus a point in space is said to have a certain electric potential, and since all points of a conductor in electrical equilibrium have the same potential, we speak of the potential of the conductor. But we do not speak of the potential of a charge of electricity, or of electricity being endowed or not endowed with potential. Such language would only lead us into error.

Let us suppose the inductor to be charged positively and the induced body to be insulated and originally without charge. Then, since its insulation prevents any electric communication with other bodies, its total electrification must remain zero, or there must be as much positive electrification as there is negative.

Hence for every line of electric force which proceeds from the inductor and falls on the induced body, there is another which proceeds from the induced body and falls on the walls of the room, or on some other body whose potential is zero. The potential of the induced body must therefore be intermediate between that of the inductor and that of the walls of the room, which is generally taken as zero. The potential of the induced body is therefore positive.

There is thus on the surface of the induced body a region nearer the inductor which is negatively electrified, and a region further from the inductor which is positively electrified. These regions are divided by a neutral line on the surface, which is the section of the surface by an equipotential surface in space which has the same potential as the induced body. The total charges on these two regions are exactly equal but of opposite signs.

If a small insulated conductor is placed in contact with any part of the surface and removed, it will be found to be electrified in the same way as the part of the surface with which it was in contact. A fine short needle point, or a burning pastille, placed on any part of the surface will dissipate the kind of electricity which exists on that part of the surface. See Riess, "Reibungs Elektricität," Art. 247.

If any part of the induced body is placed in electrical connection with the earth by touching it with a fine wire, positive electricity will be discharged, and the potential of the induced body will be reduced to zero. This will be the case whether the part touched be positively or negatively electrified. The quantity of electricity discharged will be the product of the potential of the induced body into its electric capacity.

After this discharge every part of the surface of the induced body will be negatively electrified, but the parts nearer the inductor more than those which are further from it.

In the mathematical treatment of the subject Thomson has found it convenient to divide the electrification into two parts, each distributed over the induced body according to its own law.

(α) The induced electrification when the induced body is connected to earth, and the charge of the inductor is E. This electrification is negative on every part of the surface, but the density is greatest next the inductor.

(β) The electrification when the induced body has a potential P, and the inductor, still in the same place, has no charge. This electrification is positive on every part of the surface.

From a knowledge of these two distributions it is easy to determine a third, in which the total electrification is the algebraical sum of (α) and (β), and in which the value of P is such that the total electrification is zero.

We might then assert that the electrification (β) is free, because it will be discharged if the body is connected to earth, but that the electrification (α) is latent or dissimulated, because it will not be discharged to earth.

The only danger of this mode of exposition is that it may suggest to a beginner the notion that electricity, like water and other substances, may exist in different physical states, in some of which it is more mobile than in others.

This idea of variation of quality once introduced into the

mind will tend to prevent the student from forming any clear and distinct conception of the phenomena.

Let us now examine how far M. Volpicelli's experimental skill and extensive reading have enabled him to give an accurate account of the phenomena, and how far he may have fallen into error from not availing himself of the idea of electric potential, but continuing to employ that of latent electricity.

Melloni, in his exposition, has represented the homonymous electrification (β) as greater on the side of the induced body further from the inductor. The fact, however, is that the electrification is distributed in the same way as it would be if the inductor were in its actual position and insulated, but without charge. It will therefore be densest on the projecting parts of the induced body; but if the two extremities of this body are geometrically similar, and if the inductor is made of a conducting substance, it will be somewhat denser on the extremity (B) next the inductor, because the surface of the inductor itself (C) will become electrified, and the electricity on the side next to B will be negative.

But the inequality of the distribution of the negative electrification (α) is so much greater that it completely masks that of (β), so that from an experimental point of view we must regard this error of Melloni as a very trifling one.

The next point we must notice is the mode in which objection (3) is expressed. It is as follows:—

"(3) Because of the two kinds of electricity which coexist upon the induced insulated body, only the homonym of the inductor is dissipated *by contact with the air*." (The italics are our own.)

We have no evidence whatever that electricity is ever dissipated by contact with air, whether dry or moist, unless the electric density is so great that a disruptive discharge takes place in the forms of "glow," "brush," or "spark," from sharp points connected with the electrified body.

If the electrified body and the surrounding conductors have rounded surfaces, and if the potential is moderate, it appears from the experiments of Boltzmann[1] that no measureable quantity of electricity passes through air or other gases, even when greatly rarefied, and when the experiment is continued for fourteen hours.

I have myself been unable to detect any conduction through a stratum of still air of two millimetres thickness, even when the temperature was raised to a red heat, and when steam, or the vapour of mercury or of sodium was introduced between the oppositely electrified surfaces. If, however, smoky air was introduced, there was a considerable effect arising from convection by the solid particles.

The cause of the powerful electrical effects of the stream of heated matter rising from a Bunsen's burner or from a red-hot ball, as in Guthrie's experiments, requires a special investigation.

The dissipation of the charge of insulated bodies which we actually observe seems to depend principally on the insulating supports on which they are placed, and if these are of good glass the conduction is almost entirely due to moisture on the surface of the glass. If the air which is in contact with the glass insulator is perfectly dry the dissipation of electricity will be extremely small, even when the air in contact with the electrified body itself is loaded with moisture.

It is not, therefore, by contact with the air that the electricity escapes, but by conduction to the earth along the so-called insulating supports, and the effect of this conduction is of course to reduce the potential to zero by discharging electricity of the same kind with that of the inductor.

We come next to the fourth of the five facts mentioned under the head of the First Experiment. It is stated as follows:—

"4. Points applied to the extremity of the cylinder nearest to the inductor allow only the homonym of the inductor to escape, and not at all the opposite electricity."

This will be the case if the point is electrically connected with the earth, and made to approach any part of the surface of the cylinder; but if, as the words seem rather to imply, the point is attached to the cylinder and projects into the air, then the statement is exactly opposite to that given by Riess in Art. 247 of his book, who correctly tells us that if the cylinder has a sharp point at one end, then if the point is turned towards the inductor, the cylinder becomes charged similarly to the inductor, whereas if the point is turned away from the inductor, the cylinder becomes charged oppositely to the inductor, the discharge from the point being always of that kind of electricity which exists on the part of the cylinder where the point is placed.

The fifth fact stated to be established by the experiment is—

"5. Induced electricity of the first kind (opposite to that of the inductor) is not transferred from the induced body to the inductor, but the electricity of the inductor may certainly be transferred to the induced body."

For the sake of distinctness, let us say that the inductor is positive, then it is here asserted that negative electricity does not pass from the cylinder to the inductor, but that positive electricity passes from the inductor to the cylinder.

If M. Volpicelli can give us an experimental method of distinguishing between the passage of negative electricity from B to A, and the passage of positive electricity from A to B, we may expect to learn more of the nature of electricity than any of our physicists have hitherto even hoped for.

J. CLERK MAXWELL

[1] Sitzb. der k. Akad. (Wien), April 23, 1874.

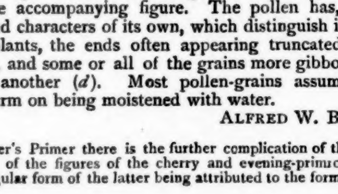
Cherry Blossoms

In the last number of NATURE (vol. xiv., p. 10), Mr. Pryor states that the flowers of the wild cherry are bitten off in large numbers in much the same manner as I formerly described in the case of the primrose. Some days ago I observed many cherry blossoms in this state, and to-day I saw some actually falling. I approached stealthily so as to discover what bird was at work, and behold it was a squirrel. There could be no doubt about it for the squirrel was low in the tree and actually had a blossom between its teeth. It is none the less true that birds likewise bite the flowers of the cherry tree.

Down, Beckenham, May 6 CHARLES DARWIN

The Pollen of the Cherry

THE practice of the indefinite reproduction of woodcuts by means of *clichés* has frequently given rise to the repetition of erroneous drawings in one scientific text-book after another. Botanical text-books seem to have suffered especially in this way, in consequence of the great dearth of new and original illustrations by which they are characterised. Many botanical students must have been puzzled by the peculiar appearance presented by the pollen of the cherry in a very familiar drawing. It is hardly sufficiently explained that "the escape of the fovilla in an irregular jet," as there represented, has nothing to do with the process of fertilisation, but is an altogether abnormal phenomenon depending on the bursting of the pollen-grain from artificial moistening. The shape of the pollen-grain, as drawn, for example, in Balfour's "Class-book of Botany," Le Maout and Decaisne's "General System of Botany," and Dr. Hooker's Science Primer "Botany"[1] is also incorrectly indicated. The perfectly spherical form represented in these drawings is almost, if not altogether, confined to anemophilous plants, fertilised by the wind. The cherry is, on the contrary, entomophilous, and its pollen partakes of the general character of this class of plants.



Though somewhat variable in size and form, the grains are, I believe, never spherical, but ellipsoidal, with three longitudinal furrows, as represented in the longitudinal and apical aspects, *a*, *b*, in the accompanying figure. The pollen has, however, well-marked characters of its own, which distinguish it from that of allied plants, the ends often appearing truncated, as represented in *c*, and some or all of the grains more gibbous on one face than another (*d*). Most pollen-grains assume a more spherical form on being moistened with water.

ALFRED W. BENNETT

[1] In Hooker's Primer there is the further complication of the accidental transposition of the figures of the cherry and evening-primrose, the well-known triangular form of the latter being attributed to the former.

Spring Dynamometers

IN a former brief communication of mine on the subject of dynamometers (NATURE, vol. xiii. p. 385), suggested by an incidental remark made by Mr. Bottomley, I observed that "about three years ago Prof. Ball when introducing the C. G. S. system of units into the course of mechanics in this College had a series of dynamometers in absolute measure specially constructed for him." In reference to this statement, Dr. Ball's successor in the chair of mechanics, Prof. Hennessy, points out, in a letter to NATURE (vol. xiii., p. 466), that "the system actually employed is not that referred to by your correspondent; I generally employ the kilogram, metre, and second, and sometimes the foot, pound, and second, to measure a dynam or unit of force." It is, however, evident that the few words in my former letter did not question the merits of any particular system of units; whether the use of a mixed system of kilogram-metres and foot-pounds be an improvement upon a system now generally coming into use is a matter of opinion. And though the subject can hardly be one of much interest to your readers, I may, perhaps, remark that so far as my statement concerns Dr. Ball it is perfectly accurate; he was in the habit of using the C. G. S. system in his classes here, and I was unaware any change had been made in this respect, the following statement occurring in Prof. Hennessy's own syllabus for the present as well as last session:—"The unit of force employed is the 'dyne,' or that force which, acting uniformly upon one gramme for one second, will give it a velocity of one centimetre a second." Even if reference had been made to Prof. Hennessy, one would naturally have concluded that the printed syllabus, authorised by the Department, was the one "actually employed."

Passing on to Dr. Ball's dynamometers, Prof. Hennessy remarks that "they cannot be depended upon to results within the tenth of a kilogramme"—finer readings when necessary could, no doubt, be taken by the eye, but that is really only a question for the maker, and the special purpose for which these instruments were designed: then follows the strong assertion that "spring dynamometers are totally unfit for measuring units on the C. G. S. system." As several instruments of precision depending on the tension of a spring recur to one's mind, instruments that only require proper precautions to yield extremely delicate and trustworthy results, it would be interesting to know upon what grounds Prof. Hennessy bases his emphatic and reiterated assertion. If it be merely a question of individual opinion, upon this subject hardly any authorities that could be quoted would carry such weight as Sir W. Thomson and Prof. P. G. Tait, who speak thus in their treatise on "Natural Philosophy," p. 127. "Spring balances we believe to be capable, if carefully constructed, of rivalling the ordinary balance in accuracy, while for some applications they far surpass it in sensibility and convenience."

Royal College of Science, Dublin W. F. BARRETT

The Meteors of April 20th

BETWEEN ten and twelve o'clock on the night of April 18th, Mr. W. L. Taylor, a member of the junior class in the State University, with several other gentlemen, observed an unusual number of shooting-stars. These gentlemen were returning in an open waggon from Ellettsville, eight miles north of Bloomington. No count was kept of the number of meteors observed, but the appearance was so frequent as to attract the attention of all the company. Mr. Taylor thinks the number noticed could not have been less than twelve or fifteen. From the descriptions given of the meteor tracks, I find that they were nearly conformable to the radiant of the Lyraïds. The meteors were remarkably brilliant, apparently equal to stars of the first or second magnitude.

At my request Mr. Benjamin Vail, a student of the University, made observations on the nights of the 19th and 20th of April. Both nights were so cloudy, however, that a continuous watch would have been useless. About eleven o'clock on the night of the 19th, three meteors were seen in the north-west, where the sky at the time was partially clear.

Bloomington, Ind., April 26 DANIEL KIRKWOOD

American Mocking Bird

AN American mocking-bird, about a year old, which I had brought from Tennessee, has, for the past three or four weeks, been affected with an irritation round the eyes, causing the feathers to fall off and the flesh to swell; the bird is otherwise in a healthy condition, but has not sung since it has been affected with the soreness; it has the proper food supplied, and its cage is kept in a clean state; could any correspondent kindly inform me the cause and cure of the disease? M. C.

An Unusual Optical Phenomenon

THIS morning, a little after nine o'clock, the ordinary solar halo, radius about 22°, was seen. It was bright, and the red very distinct.

On turning to the north to find the direction of the cloud drift, a white band was seen extending to the north-east in one direction, and on to the west and south in the other. Its width was about that of the halo near the sun. A pair of compasses and a protractor gave the altitude of this circle about 45°. This being about the sun's altitude, the plane of the circle was no doubt parallel to the horizon and passed through the sun. I believe the circle above described to be but rarely seen.

JOSEPH GLEDHILL

Mr. Crossley's Observatory, Halifax, May 3

OUR ASTRONOMICAL COLUMN

THE BINARY λ OPHIUCHI.—An examination of the recent measures of this star, shows that neither of the orbits computed some 25 or more years since by Mädler and Hind at all represents the later course of the companion, a circumstance mainly attributable, as it appears, to error in one, if not in both, of Sir W. Herschel's measures. Struve at first considered that the angle of 1783 required a correction of 180°, but at a later period he was inclined to apply a similar correction to the angle of 1802, and Dawes also believed it was the latter measure which required alteration, in order to render any orbit possible. It is upon this supposition that the orbits of Mädler and Hind have been calculated: the two sets of elements are subjoined:—

	Mädler.	Hind.
Peri-astron passage	1790·31	1791·21
Period of revolution in years	89·01	95·88
Node	32° 42′	30° 23′
Angle between the lines of nodes and apsides on orbit	126° 4′	135° 24′
Inclination	49° 25′	49° 40′
Excentricity	0·4530	0·4772
Semi-axis major	0″·842	0″·847

Mädler's orbit was published in "Untersuchungen über die Fixsterne-Systeme, Erster Theil." The second orbit was founded upon observations to about the same year, 1849. The projection of the measures since this epoch, however, makes it apparent that the real orbit must be materially different from the above, and the star may be recommended to the attention of those who are interested in the determination of elements of the revolving double-stars.

Sir W. Herschel's papers containing his measures of double stars communicated to the Royal Society, not being always of easy access, the following extracts from his notes on λ Ophiuchi may perhaps prove useful:—

From the *Phil. Trans.*, vol. lxxv., p. 62:—

"I. 83; 1783, March 9. A very beautiful and close double-star, L. w.; S. blue; both fine colours. Considerably or almost very unequal. With 460, ¼ or ⅓ diameter of S.; with 932 full ⅓ diameter of S. Position 14° 30′ n. following."

From the memoir of 1804—

"May 20, 1802, position was 20° 41′. The position March 9, 1783, was 14° 30′, north following. The difference in nineteen years and seventy-two days is 6° 11′. May 1 and 2, 1802, I could not perceive the small star, though the last of the two evenings was very fine. May 20, 1802, with 527, I saw it very well, but with great difficulty. The object is uncommonly beautiful, but it requires a most excellent telescope to see it well and the focus ought to

be adjusted upon ϵ of the same constellation, so as to make that perfectly round."

These remarks have an essential bearing upon the investigation of elements. The components must have been very close at both Herschel's epochs—if there be no mistake in the register—and this is not at first sight readily explained by the curve exhibiting the motion of the smaller star from Struve's earliest micrometrical measures in 1825 to the present date.

Herschel further remarked in 1802 that the appearance of the components was much like that of "a planet with a large satellite, or small companion," and strongly suggestive of "the idea of a connection between the two bodies, especially as they are much insulated."

THE ROTATION OF VENUS.—In a note upon the time of rotation and position of the axis of Venus, which recently appeared in this column, reference was inadvertently omitted to Flaugergues' observations at Viviers in July, 1796, which, according to a communication from Valz to the *Astronomische Nachrichten* (No. 278, vol. xi), seemed to favour Bianchini's period, and placed the north pole of Venus in longitude 321° 20′, with an elevation of 16° 28′. Details of the observations are wanting, but Valz states that Flaugergues observed with "une ancienne lunette à deux verres de 18 pieds de long, amplifiant 105 fois qu'il dit fort bonne." He also employed one of 14 feet, and a telescope said to be good, which Legentil brought from India. Valz adds: "J'ai vu le dessein original de la tache, elle etait grande et de forme trapezoide arrondie, &c."

Hussey's vigorous but prejudiced defence of the extraordinary period of rotation assigned by Bianchini will be found in *Astronomische Nachrichten*, No 248.

Fritsch, of Quedlinburg, thought some observations of his in April 1801 indicated a period of 23h. 22m. (*Berliner Astronomisches Jahrbuch*, 1804, p. 213).

SONG OF THE SCREW

A MOVING form or rigid mass,
Under whate'er conditions,
Along successive screws must pass
Between each two positions.
It *turns around* and *slides along*—
This is the burden of my song.

The *pitch of screw*, if multiplied
By angle of rotation,
Will give the distance it must glide
In motion of translation.
Infinite pitch means pure translation,
And zero pitch means pure rotation.

Two motions on two given screws,
With amplitudes at pleasure,
Into a third screw-motion fuse;
Whose amplitude we measure
By parallelogram construction
(A very obvious deduction).

Its axis cuts the nodal line
Which to both screws is normal,
And generates a form divine,
Whose name, in language formal,
Is "surface-ruled of third degree."
Cylindroid is the name for me.

Rotation round a given line
Is like a *force* along.
If to say *couple* you incline,
You're clearly in the wrong;—
'Tis obvious, upon reflection,
A line is not a mere direction.

So *couples* with *translations* too
In all respects agree;
And thus there centres in the screw
A wondrous harmony
Of Kinematics and of Statics,—
The sweetest thing in mathematics.

The forces on one given screw,
With motion on a second,
In general some work will do,
Whose magnitude is reckoned
By angle, force, and what we call
The *coefficient virtual*.

Rotation now to force convert,
And force into rotation;
Unchanged the work, we can assert,
In spite of transformation.
And if two screws no work can claim,
Reciprocal will be their name.

Five numbers will a screw define,
A screwing motion, six;
For four will give the axial line,
One more the pitch will fix;
And hence we always can contrive
One screw reciprocal to five.

Screws—two, three, four, or five, combined
(No question here of sex),
Yield other screws which are confined
Within one *screw complex*.
Thus we obtain the clearest notion
Of *freedom* and *constraint* of motion.

In complex III. three several screws
At every point you find,
Or if you one direction choose,
One screw is to your mind;
And complexes of order III.
Their own reciprocals may be.

In IV., wherever you arrive,
You find of screws a cone.
On every line in complex V.
There is precisely one;
At each point of this complex rich,
A plane of screws have given pitch.

But time would fail me to discourse
Of Order and Degree,
Of Impulse, Energy, and Force,
And Reciprocity.
All these and more, for motions small,
Have been discussed by Dr. Ball.

ON THE TELEPHONE, AN INSTRUMENT FOR TRANSMITTING MUSICAL NOTES BY MEANS OF ELECTRICITY

MR. ELISHA GRAY recently read a paper before an American Society explaining his apparatus for transmitting musical notes by electricity. He showed experimentally how, by means of a current of electricity in a single wire, a number of notes could be reproduced simultaneously at a great distance, and how by this means also a number of telegraphic messages could be transmitted at once along a wire and separately received at the other end. One of Mr. Gray's apparatuses was exhibited in London at the last *soirée* of the Society of Telegraph Engineers by the president, Mr. Latimer Clark. The principle of the apparatus is as follows:—

A vibrating reed is caused to interrupt the electric current entering the wire a certain number of times per second and the current so interrupted at the sending end sets a similar reed vibrating at the distant end.

The sending reed is ingeniously maintained in constant vibration by a pair of intermittent electro-magnets which are magnetised and demagnetised by the vibrating reed itself.

Thus in Fig. 1 (which represents the transmitting part of the telephone and its connections for a single note), the current from the magnet battery flowing in the direction of the small arrow passes through the pair of electro-magnets A to the terminal *r* of the reed R, and thence by the spring contact *b* and the wire *bz* to the battery again, completing its circuit without passing through the other pair of electro-magnets B, which are not therefore magnetised. The reed R is consequently pulled over by the electro-magnets A. But on this taking place the spring contact *b* is broken and the circuit is no longer completed through *bz* but through the electro-magnets B, which are consequently magnetised, and tend by their induction on the reed to neutralise that of B. The reed

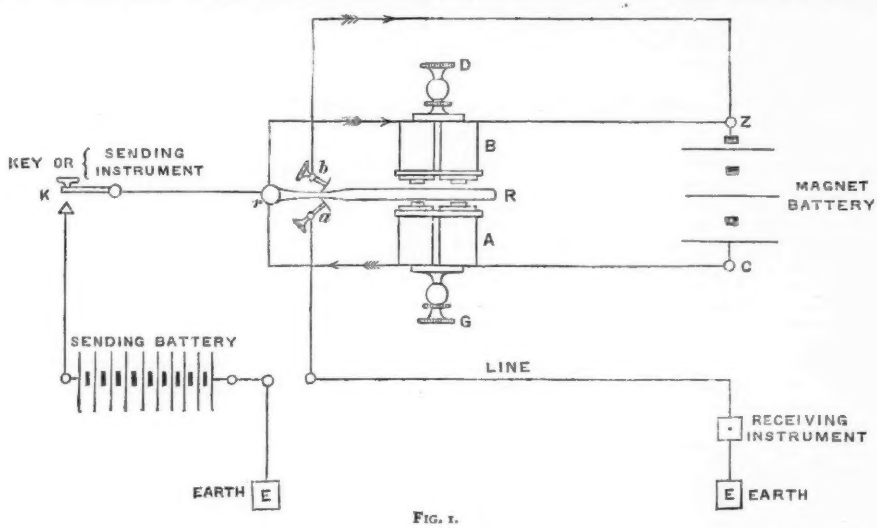


FIG. 1.

therefore springs back to its intermediary position, but in so doing the contact at *b* is again made and the electro-magnets B again short-circuited and the reed pulled over (or rather *assisted* over, for it has its own resilience or spring) towards A; so this goes on keeping the reed in vibration between the electro-magnets and alternately making and breaking the spring contact *b* and also that of *a*, the number of contacts per second being dependant on the vibrating period of the reed.

While this is going on the reed of course emits its musical note. Two Leclanché or bichromate cells are sufficient to work the transmitter and give a good note.

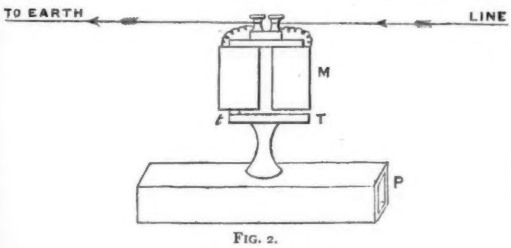


FIG. 2.

The spring contact *b* is to be adjusted by the screw there seen until the note emitted by the reed is both loud and pure. The magnets A and B are adjustable to or from the reed by the milled heads C and D.

The spring contact *a* just mentioned belongs properly to the line circuit. It is the intermittent contact which interrupts the current sent into the line. As will be seen from the diagram the circuit of the sending battery is made through the key K, the reed, and the spring contact *a*. On holding down the key K the current flows into the line, being interrupted, however, by the contact *a* as many times per second as the reed vibrates, and this intermittent current flowing to earth at the distant station, is made to elicit a corresponding note from the receiving apparatus there.

The receiving instruments are of two kinds, electro-magnetic and physiological.

In the first there is a plain double electro-magnet with a steel tongue having one end rigidly fixed to one pole, the other end being free to vibrate under the other pole. This stands over a wooden pipe closed at one end. Thus in Fig. 2 *t* T is the steel tongue fixed at *t* and free at

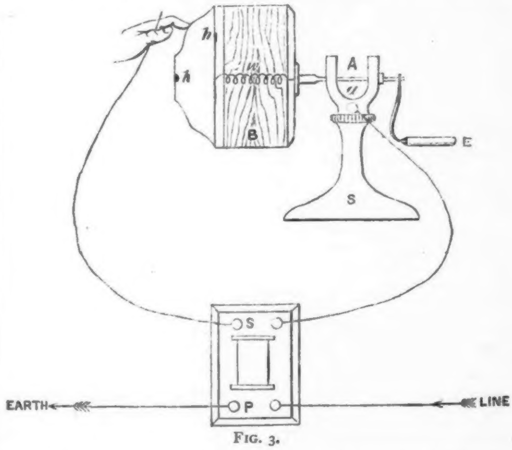


FIG. 3.

T, while P is the sounding-pipe. The received current, coming from the line and passing through the electro-magnet M to earth, sets the tongue vibrating, and the pipe gives forth the same note as the reed at the sending station. Ten Daniell cells working through 1,000 ohms, give a good strong note, especially when the receiver is

held in the hand close to the head. The screw *a*, Fig. 1, must be adjusted to give the best effect.

The other receiving instrument is the most interesting of the two. It consists of a small induction coil used in conjunction with a peculiar sounding-box, as shown in Fig. 3.

Here the line-current is passed to earth through the primary circuit P of the small induction coil, and the induced current is led to the sounding-box. This consists of a flat hollow cylindrical wooden box B, covered by a convoluted face of sheet zinc with two air holes *h h*, perforated in it, this box is attached to a metal axle A, turning in forked iron bearings, insulated from but supported by an iron stand S. By this means the sounding-box can be revolved by the ebony handle E. The zinc face is connected across the empty interior of the box by a wire W to the metal bearings on the other side. One end of the secondary circuit of the induction coil is to be connected to the metal bearing by the terminal *a*, and the other to a short bare wire held in the left hand. On then striking a finger of the hand holding the wire smartly across the zinc face, the proper note is sounded by the box; or, what is more convenient, on turning the box by the insulated handle and keeping the point of the finger rubbing on its face, the note is heard. The rough under side of the finger pressed pretty hard on the bulging part of the face is best. The instant the current is put on by the sending key K, Fig. 1, the dry rasp of the skin on the zinc-surface becomes changed into a musical note.

These "sounders" can be made to receive indifferently a variety of notes. I have under my care at present a telephone with four transmitters tuned to give the four notes of the common chord, and two receivers, which interpret equally well any one of these notes or all together. But sounders are also made in the same way which will emit only one special note, and so are sensible only to the corresponding current. It is by their means that the telephone can be applied to multiplex telegraphy. As many as eight transmitters may be set to interrupt the line current according to the vibrations of eight different tuning-forks, and the resultant current can be made by means of eight special receivers to reproduce the same number of corresponding notes at the distant station. The current is controlled by eight keys at the sending end and sifted by eight sounders at the receiving end, each sounder being sensitive only to those portions of the current affected by its corresponding transmitter. The superimposed effect of the eight keys and transmitters on the line current can all be separately interpreted at the receiving end. Thus eight messages might be transmitted simultaneously along one wire in the same direction. It would seem hitherto, however, that this method of telegraphy by the telephone is inferior to the ordinary methods in point of speed of signalling, and in the length of circuit which can be worked by a given battery power.

J. MUNRO

OUR PERCEPTION OF THE DIRECTION OF A SOURCE OF SOUND[1]

THE practical facility with which we recognise the situation of a sounding body has always been rather a theoretical difficulty. In the case of sight a special optical apparatus is provided whose function it is to modify the uniform excitation of the retina, which a luminous point, wherever situated, would otherwise produce. The mode of action of the crystalline lens of the eye is well understood, and the use of a lens is precisely the device that would at once occur to the mind of an optician ignorant of physiology. The bundle of rays, which would otherwise distribute themselves over the entire retina, and so give no indication of their origin, are made to converge upon a single point, whose excitation is to us the sign of an external object in a certain definite direction. If the luminous object is moved, the fact is at once recognised by the change in the point of excitation.

There is nothing in the ear corresponding to the crystalline lens of the eye, and this not accidentally, so to speak, but by the very nature of the case. The efficient action of a lens depends upon its diameter being at least many times greater than the wave-length of light, and for the purposes of sight there is no difficulty in satisfying this requirement. The wave-length of the rays by which we see is not much more than a ten-thousandth part of the diameter of the pupil of the eye. But when we pass to the case of sound and the ear the relative magnitudes of the corresponding quantities are altogether different. The waves of sound issuing from a man's mouth are about eight feet long, whereas the diameter of the passage of the ear is quite small, and could not well have been made a large multiple of eight feet. It is evident therefore that it is useless to look for anything corresponding to the crystalline lens of the eye, and that our power of telling the origin of a sound must be explained in some different way.

It has long been conjectured that the explanation turns upon the combined use of both ears; though but little seems to have been done hitherto in the way of bringing this view to the test. The observations and calculations now brought forward are very incomplete, but may perhaps help to clear the ground, and will have served their purpose if they induce others to pursue the subject.

The first experiments were made with the view of finding out with what degree of accuracy the direction of a sound could be determined, and for this it was necessary of course that the observer should have no other material for his judgment than that contemplated.

The observer, stationed with his eyes closed in the middle of a lawn on a still evening, was asked to point with the hand in the direction of voices addressed to him by five or six assistants, who continually shifted their position. It was necessary to have several assistants, since it was found that otherwise their steps could be easily followed. The uniform result was that the direction of a human voice used in anything like a natural manner could be told with certainty from a single word, or even vowel to within a few degrees.

But with other sounds the result was different. If the source was on the right or the left of the observer, its position could be told approximately, but it was uncertain whether, for example, a low whistle was in front or behind. This result led us to try a simple sound, such as that given by a fork mounted on a resonance box. It was soon found that whatever might be the case with a truly simple sound, the observer never failed to detect the situation of the fork by the noises accompanying its excitation, whether this was done by striking or by a violin bow. It was therefore necessary to arrange the experiment differently. Two assistants at equal distances and in opposite directions were provided with similar forks and resonators. At a signal given by a fourth, *both* forks were struck, but only *one* was held over its resonator, and the observer was asked to say, without moving his head, which he heard. When the observer was so turned that one fork was immediately in front and the other immediately behind, it was impossible for him to tell which fork was sounding, and if asked to say one or the other, felt that he was only guessing. But on turning a quarter round, so as to have one fork on his right and the other on his left, he could tell without fail, and with full confidence in being correct.

The possibility of distinguishing a voice in front from a voice behind would thus appear to depend on the compound character of the sound in a way that it is not easy to understand, and for which the second ear would be of no advantage. But even in the case of a lateral sound

[1] Abstract of a Communication to the Musical Association, by Lord Rayleigh, F.R.S.

the matter is not free from difficulty, for the difference of intensity with which a lateral sound is perceived by the two ears is not great. The experiment may easily be tried roughly by stopping one ear with the hand, and turning round backwards and forwards while listening to a sound held steadily. Calculation shows, moreover, that the human head, considered as an obstacle to the waves of sound, is scarcely big enough in relation to the wave-length to give a sensible shadow. To throw light on this subject I have calculated the intensity of sound due to a distant source at the various points on the surface of a fixed spherical obstacle. The result depends on the ratio (a) between the circumference of the sphere and the length of the wave. If we call the point on the spherical surface nearest to the source the anterior pole, and the opposite point (where the shadow might be expected to be most intense) the posterior pole, the results on three suppositions as to the relative magnitudes of the sphere and wave-length are given in the following table:—

		Intensity.
$a = 2$	Anterior pole	·690
	Posterior pole	·318
	Equator	·356
$a = 1$	Anterior pole	·503
	Posterior pole	·285
	Equator	·237
$a = \frac{1}{2}$	Anterior pole	·294
	Posterior pole	·260
	Equator	·232

When, for example, the circumference of the sphere is but half the wave-length, the intensity at the posterior pole is only about a tenth part less than at the anterior pole, while the intensity is least of all in a lateral direction. When a is less than $\frac{1}{2}$, the difference of the intensities at the two poles is still less important, amounting to about one per cent. when $a = \frac{1}{4}$.

The value of a depends on the wave-length, which may vary within pretty wide limits, and it might be expected that the facility of distinguishing a lateral sound would diminish when the sound is grave. Experiments were accordingly tried with forks of a frequency of 128, but no greater difficulty was experienced than with forks of a frequency of 256, except such as might be attributed to the inferior loudness of the former. According to calculation the difference of intensity would here be too small to account for the power of discrimination.

PROF. HUXLEY'S LECTURES ON THE EVIDENCE AS TO THE ORIGIN OF EXISTING VERTEBRATE ANIMALS[1]

VI.

IN the highest group of Vertebrates, the Mammalia, the perfection of animal structure is attained. It will hardly be necessary, indeed it will be impossible, in the time at our disposal, to give the general characters of the group, but our purpose will be answered as well by devoting a short time to considering the peculiarities of a single well-known animal, the evidence as to the origin of which approaches precision.

The horse is one of the most specialised and peculiar of animals, its whole structure being so modified as to make it the most perfect living locomotive engine which it is possible to imagine. The chief points in which its structure is modified to bring about this specialisation, and in which, therefore, it differs most markedly from other mammals, we must now consider.

In the skull the orbit is completely closed behind by bone, a character found only in the most modified mammals. The teeth have a very peculiar character. There are, first of all, in the front part of each jaw, six long curved incisors or cutting teeth, which present a singular dark mark on their biting surfaces, caused by the filling in of a deep groove on the crown of each tooth, by the substances on which the animal feeds. After the incisors, comes on both sides of each jaw a considerable toothless interval, or *diastema*, and then six large grinding teeth, or molars and premolars. In the young horse a small extra premolar is found to exist at the hinder end of the diastema, so that there are, in reality, seven grinders on each side above and below; furthermore, the male horse has a tusk-like tooth, or canine, in the front part of the diastema immediately following the last incisor. Thus, the horse has, on each side of each jaw, three incisors, one canine, and seven grinders, making a total of forty-four teeth.

The grinding surfaces of the molars and premolars are very curious. In the upper jaw, each tooth is marked by four crescentic elevations, concave externally, the inner pair having each a curious folded mass connected with it. These projecting marks are formed of dentine and enamel, and, consequently, wear away more slowly than the intervening portions of the tooth, which are composed of cement. The lower grinders are marked with two crescents and two accessory masses, but the crescents are convex externally, and, consequently, when the opposite teeth bite together, the elevations do not correspond at any point. In this way a very perfect grinding surface is obtained. The teeth are of great length, and go on growing for a long time, only forming roots in old animals. All these points contribute to the perfection of the horse as a machine, by rendering the mastication of the food, and its consequent preparation for digestion in the stomach, as rapid and complete a process as possible.

It is, however, in the limbs that the most striking deviation from the typical mammalian structure is seen, the most singular modifications having taken place to produce a set of long, jointed levers, combining great strength with the utmost possible spring and lightness.

The humerus is a comparatively short bone inclined backwards: the radius is stout and strong, but the ulna seems to be reduced to its upper end—the olecranon or elbow; as a matter of fact, however, its distal end is left, fused to the radius, but the middle part has entirely disappeared: the carpus or wrist—the so-called "knee" of the horse—is followed by a long "cannon-bone," attached to the sides of which are two small "splint-bones"; the three together evidently represent the metacarpus, and it can be readily shown that the great cannon-bone is the metacarpal of the third finger, the splint-bones those of the second and fourth. The splint-bones taper away at their lower ends and have no phalanges attached to them, but the cannon-bone is followed by the usual three phalanges, the last of which, the "coffin-bone," is ensheathed by the great nail or hoof.

The femur, like the humerus, is a short bone, but is directed forwards; the tibia turns backwards, and has the upper end of the rudimentary fibula attached to its outer angle. The latter bone, like the ulna, has disappeared altogether as to its middle portion, and its distal end is firmly united to the tibia. The foot has the same structure as the corresponding part in the fore-limb—a great cannon-bone, the third metatarsal; two splints, the second and fourth; and the three phalanges of the third digit, the last of which bears a hoof.

Thus, in both fore and hind limb one toe is selected, becomes greatly modified and enlarged at the expense of the others, and forms a great lever, which, in combination with the levers constituted by the upper and middle divisions of the limb, forms a sort of double C-spring arrangement, and thus gives to the horse its wonderful galloping power.

In the river-beds of the Quaternary age—a time when England formed part of the Continent of Europe—

[1] A course of six lectures to working men, delivered in the theatre of the Royal School of Mines. Lecture VI., April 3. Continued from vol. xiii. p. 516.

abundant remains of horses are found, which horses resembled altogether our own species, or perhaps are still more nearly allied to the wild ass. The same is the case in America, where the species was very abundant in the Quaternary epoch—a curious fact, as, when first discovered by Europeans, there was not a horse from one end of the vast continent to the other.

In the Pliocene and older Miocene, both of Europe and America, are found a number of horse-like animals, resembling the existing horse in the pattern and number of the teeth, but differing in other particulars, especially the structure of the limbs. They belong to the genera *Protohippus*, *Hipparion*, &c., and are the immediate predecessors of the Quaternary horses.

In these animals the bones of the fore-arm are essentially like those of the horse, but the ulna is stouter and larger, can be traced from one end to the other, and, although firmly united to the radius, was not ankylosed with it. The same is true, though to a less marked extent, of the fibula.

But the most curious change is to be found in the toes. The third toe though still by far the largest, is proportionally smaller than in the horse, and each of the splint bones bears its own proper number of phalanges; a pair of "dew-claws," like those of the reindeer, being thus formed, one on either side of the great central toe. These accessory toes, however, by no means reached the ground, and could have been of no possible use, except in progression through marshes.

The teeth are quite like those of the existing horse, as to pattern, number, presence of cement, &c.; the orbit also is complete, but there is a curious depression on the face-bones, just beneath the orbit, a rudiment of which is, however, found in some of the older horses.

On passing to the older Miocene, we find an animal, known as *Anchitherium*, which bears, in many respects, a close resemblance to Hipparion, but is shorter-legged, stouter-bodied, and altogether more awkward in appearance. Its skull exhibits the depression mentioned as existing in Hipparion, but the orbit is incomplete behind, thus deviating from the specialised structure found in the horse, and approaching nearer to an ordinary typical mammal. The same is the case with the teeth, which are short and formed roots at an early period; their pattern also is simplified, although all the essential features are still retained. The valleys between the various ridges are not filled up with cement, and the little anterior premolar of the horse has become as large as the other grinders, so that the whole forty-four teeth of the typical mammalian dentition are well developed. The diastema is still present between the canines and the anterior grinding teeth—a curious fact in relation to the theory that the corresponding space in the horse was specially constructed for the insertion of the bit; for, if the Miocene men were in the habit of riding the Anchitherium, they were probably able to hold on so well with their hind legs as to be in no need of a bit.

The fibula is a complete bone, though still ankylosed below to the tibia; the ulna also is far stouter and more distinct than in Hipparion. In both fore and hind foot the middle toe is smaller, in relation to the size of the animal, than in either the horse or the Hipparion, and the second and fourth toes, though still smaller than the third, are so large that they must have reached the ground in walking. Thus, it is only necessary for the second and fourth toes, and the ulna and fibula to get smaller and smaller for the limb of Anchitherium to be converted into that of Hipparion, and this again into that of the horse.

Up to the year 1870 this was all the evidence we had about the matter, except for the fact that a species of *Palæotherium* from the older Eocene was, in many respects, so horse-like, having, however, well-developed ulna and fibula, and the second and fourth toes larger even than in Anchitherium, that it had every appearance of being the original stock of the horse. But within the last six years some remarkable discoveries in central and western North America, have brought to light forms which are, probably, nearer the direct line of descent than any we have hitherto known.

In the Eocene rocks of these localities, a horse-like animal has been found, with three toes, like those of Anchitherium, but having, in addition, a little style of bone on the outer side of the fore foot, evidently representing the fifth digit. This is the little *Orohippus*, the lowest member of the Equine series.

This evidence is conclusive as far as the fact of evolution is concerned, for it is preposterous to assume that each member of this perfect series of forms has been specially created; and if it can be proved—as the facts adduced above certainly do prove—that a complicated animal like the horse may have arisen by gradual modification of a lower and less specialised form, there is surely no reason to think that other animals have arisen in a different way.

This case, moreover, is not isolated. Every new investigation into the Tertiary mammalian fauna brings fresh evidence, tending to show how the rhinoceros, the pigs, the ruminants, have come about. Similar light is being thrown on the origin of the carnivora, and also, in a less degree, on that of all the other groups of mammals.

It may well be asked why such clear evidence should be obtainable as to the origin of mammals, while in the case of many other groups—fish, for instance—all the evidence seems to point the other way. This question cannot be satisfactorily answered at present, but the fact is probably connected with the great uniformity of conditions to which the lower animals are exposed, for it is invariably the case that the higher the position of any given animal in the scale of being, the more complex are the conditions acting on it.

It is not, however, to be expected that there should be, as yet, an answer to every difficulty, for we are only just beginning the study of biological facts from the evolutionary point of view. Still, when we look back twenty years to the publication of the "Origin of Species," we are filled with astonishment at the progress of our knowledge, and especially at the immense strides it has made in the region of palæontological research. The accurate information obtained in this department of science has put the *fact* of evolution beyond a doubt; formerly, the great reproach to the theory was, that no support was lent to it by the geological history of living things; now, whatever happens, the fact remains that the hypothesis is founded on the firm basis of palæontological evidence.

THE LOAN COLLECTION CONFERENCES

CONSIDERABLE progress has been made in the arrangements for holding conferences in connection with the approaching Loan Collection of Scientific Apparatus at South Kensington.

In the Section of Mechanics, which includes Pure and Applied Mathematics and Measurement, the conferences will be held on May 17, 22, and 25, and the following gentlemen have promised to give addresses or to take part:—

Dr. Siemens, F.R.S., general address with special reference to Measurement.

Mr. F. J. Bramwell, F.R.S., on Prime Movers.

Mr. Barnaby, Director of Naval Construction to the Admiralty.—Naval Architecture.

Mr. W. Froude, M.A., F.R.S.—Fluid Resistance.

M. Tresca, Sous-Directeur du Conservatoire des Arts et Métiers, Paris.—Flow of Solids.

M. le Général Morin, Directeur du Conservatoire des Arts et Métiers, Paris.—Ventilation of Public Buildings.

Sir Joseph Whitworth, Bart., F.R.S.—Linear Measurement.

Prof. Goodeve, M.A.—Solid Measurement.
Prof. Kennedy, C.E.—Kinematics.
Mr. W. Hackney.—Furnaces.
Prof. Sir W. Thomson, LL.D., F.R.S.—Electrical Measurement.
Mr. Westmacott.—Hydraulic Transmission.
Prof. Tilser (Bohemian Polytechnic Institute, Prague).—His new Method of Descriptive Geometry.

In the Section of Physics (including Astronomy), the following arrangements have been made provisionally:—

May 16.—Address by the President, Mr. Spottiswoode; Mr. Norman Lockyer, Capt. Abney, and Mr. Huggins—Spectroscopy; Prof. Clifton—Interference; Professors Adams and Stokes, and Mr. Spottiswoode—Polarisation; Mr. Sorby, or Dr. Royston Pigott—Microscopes; M. Becquerel and Prof. Stokes—Fluorescence; Sir W. Thomson—Electrometers.

May 19.—Prof. Tyndall—Reflection of Sound; Prof. Adams—Wheatstone's Researches; Prof. Guthrie—Heat; Mr. De la Rue—Astronomical Photography; and M. Leverrier.

May 24.—Prof. Clerk-Maxwell, Prof. Andrews, and M. Tresca—Molecular Construction of Matter; Mr. De la Rue—Electric Batteries; Prof. Carey Foster—Galvanometers; Baron Ferdinand von Wrangel—Voltameters; M. Viandel—Gramme's Machine; and M. Helmholtz.

The conferences in Chemistry will be held on the 18th and 23rd May, and the following communications have been promised:—

Address by the Chairman, Dr. Frankland, F.R.S., generally on the objects exhibited in this section, and specially on the instruments used for the investigation of gases.

Dr. J. H. Gilbert, F.R.S., on some points in connection with vegetation.

Mr. Donkin, Demonstrator of Chemistry in the Oxford Museum, on Sir B. Brodie's apparatus used in the investigation of ozone.

M. Fremy, Membre de l'Institut de France, on the preservation of animal food.

Prof. Roscoe, F.R.S., on Vanadium and its compounds.

Prof. Guthrie, F.R.S., on Cryohydrates.

The conferences in Biology will be held on May 26 and 29, and will relate chiefly to the following subjects, viz.:—(1) The methods of measurement and registration which are applicable to the vital phenomena of plants, animals, and man; (2) the methods and instruments employed in physiological optics and acoustics; and (3) the modes of preparing the tissues of plants and animals for microscopical examination. Explanations of apparatus and instruments will be given by the President, Professors Donders, Hering, Marey, Crum Brown, M. Foster, Flower, M'Kendrick, Thiselton Dyer, Messrs. Liebreich, Pritchard, Mosso, Gaskell, and others.

The Conferences in Physical Geography, Geology, Mineralogy, and Meteorology will be held on May 30, and June 1 and 2, and the following gentlemen have promised to take part:—

Mr. John Evans, F.R.S., general address on the objects exhibited in the section. In Meteorology, Prof. Roscoe, Mr. T. Stevenson, Mr. R. H. Scott, Mr. G. J. Symons, Dr. Mann, and Mr. Galloway. In Geography, Major Anderson, Lieut. Cameron, Mr. Clements Markham, Col. Walker, Professeur Forel, Prof. Wyville Thomson, and Mr. Francis Galton. In Geology and Mining, M. Daubrée, Prof. Ramsay, Mr. Rance, Baron Von Ettinghausen, and Mr. Topley. In Mineralogy, &c., M. des Cloiseaux, and the Rev. N. Brady.

NOTES

THE Eighth Annual Report of the Geological and Geographical Survey of the Territories, under the direction of Prof. F. V. Hayden, has just been issued from the U.S. Government Printing Office. It is a report of progress of the explorations, mainly in Colorado, for the year 1874, and contains twelve articles in 500 octavo pages, and eighty-eight illustrations, including maps and sections. It commences with an introductory letter to the Secretary of the Interior, under whose auspices the survey is conducted, which contains a general account of the organisation of the various field divisions, and the progress of the work. Following this is the part devoted to geology, mineralogy, and mining industry, containing the reports of Prof. Hayden, Wm. H. Holmes, Dr. A. C. Peale, Dr. F. M. Endlich, and Samuel Aughey, Ph.D. Dr. Hayden's report is devoted to the special geology of the eastern part of the Rocky Mountains in Colorado, the Arkansas Valley, and portions of the Elk Mountains. The report of Wm. H. Holmes is devoted to the geology of the north-western portion of the Elk Mountains. The report of Dr. A. C. Peale gives the general and special features of the district assigned to the middle division of the survey, viz., the country lying between the Grand and Gunnison rivers west of the 107th meridian. Dr. F. M. Endlich reports on the San Juan country, giving chapters on the metamorphic, volcanic, and sedimentary areas and mines of the region. All these reports are abundantly illustrated with woodcuts, sections, and geological maps. Dr. Samuel Aughey has an interesting and practical report on the superficial deposits in Nebraska. The second paper is devoted to palæontology, and contains papers on the flora of the lignitic formations of North America, by Mr. Leo Lesquereux. A large number of new fossil plants are described and illustrated in eight plates. Following the palæontology is the report of Mr. W. H. Jackson on the ancient ruins of South-western Colorado. Eight plates of the cliff-houses, cave-dwellings, and other ruins of the Mancos, McElmo, and Hovenweep rivers accompany the report. Following Mr. Jackson's interesting report is an article on the zoological work for 1874. It contains descriptions and figures of several new species in conchology. The last division of the volume comprises the portion devoted to topography and geography, containing the following reports:—Mr. Henry Gannett's on the middle district, Mr. S. B. Ladd's on the northern district, and Mr. A. D. Wilson's and Franklin Rhoda's on the San Juan or southern district. These reports give the general topographical features of the areas surveyed, the means of communication and elevations of principal points. A complete table of contents and exhaustive indexes accompany the report. There is a general index of systematic names.

ORDERS have been given by the French Minister of Public Works for entering into a contract for the construction of the large refractor, whose length will be seventeen metres. A sum of 210,000 francs is to be paid to M. Eichers when the work is completed. The huge instrument is to be delivered two years hence. It will not be placed under a movable shade like the great reflector, but a cupola of requisite dimensions is to be constructed. All these arrangements have already been devised by M. Leverrier.

IN a lecture on the Geographical Distribution of Birds, the first of a course delivered by Mr. R. B. Sharpe, on the 2nd inst., at the St. John's Wood Assembly Rooms, the lecturer exhibited, by the oxycalcium light, a large series of maps of the world, about fifty in number, each coloured in that part only where the bird he was speaking of is distributed. A carefully-painted slide of the bird, from the pencil of Mr. Keulemans, was also introduced with the description of the plumage of each species, and in association with the map of its distribution.

A PLAGUE of Field Voles (*Arvoricola agrestis*) has recently visited some of the pastoral farms of Upper Teviotdale and the adjoining districts, which has led to the appointment of a committee of the Farmers' Club of the Locality for the purpose of

estimating the amount of the damage done. This was found to be very considerable, the vermin eating the pale and succulent bases of the grass, as well as the young shoots. No great destruction of other vermin has occurred in the district, so it cannot be said that the Voles have become particularly abundant from that cause. Similar plagues have before now occurred in the New Forest.

A SCIENTIFIC Society and Field Club has been formed in the northern burgh of Inverness. We have received the inaugural address of the President, Mr. William Jolly, on "The Scientific Materials of the North and our Scientific Work." Mr. Jolly has lofty ideas of what the work and influence of such a society should be, and we hope his address will have a stirring effect upon the members. Inverness is a fine centre for a field-club, especially in the region of geology. We are also glad to see that a Monmouthshire Geological Society has just been formed; its first general meeting was held on the 2nd inst.

THE *Geographical Magazine* for May contains an article on the prospects for the Arctic Campaign of 1876. While we must be prepared for the necessity of the ships spending a second winter in the north, the writer thinks that possibly the *Pandora*, which goes out this month for news and letters, may meet them coming out of Smith Sound, "with their work done, their great enterprise completed." There is also an article, with map, on the Island of Socotra, which the British Government have arranged to occupy, and another by M. Venyukof on New Maps of Mongolia.

THE Supplementary Part, 46, of *Petermann's Mittheilungen* consists of a valuable memoir on the Pekin Plain and the neighbouring Mountain-land, by Dr. Bretschneider, Physician to the Russian Embassy at Pekin. It is accompanied by a map of Pekin and the district around.

AT the Royal Geographical Society on Monday the following papers were read:—"The Country and Natives of Port Moresby, New Guinea," by Mr. O. C. Stone, and "The Natives and Products of Fly River, New Guinea," by Signor L. M. D'Albertis. Mr. Stone's paper gave some details of the country and the people, speaking, on the whole, well of the latter. Signor D'Albertis's paper gave somewhat similer details as to the country in the neighbourhood of the Fly River. Dr. Mullens read a few notes, in which he described the details of his excursions in different parts of Central New Guinea. Sir Henry Rawlinson hoped a "Cameron" for New Guinea would soon turn up, and that Mr. Young would be the coming explorer, and would force himself into the large and comparatively unknown regions of New Guinea.

LETTERS from Sydney, dated March 17, inform us that the Governor of New South Wales has provided M. D'Albertis with a steam-launch for the exploration of the Fly River, and that he was intending to return to New Guinea ten days later. A public meeting was to be called at Sydney to provide for M. D'Albertis's other expenses in connection with the expedition.

AT the Crystal Palace Aquarium the hatching of the spawn of Axolotls has been successfully accomplished. There are three young "broods," and some still unhatched spawn, so that the changes in growth during the first few weeks can be seen all together.

WE greatly regret to learn that the Massachusetts House of Representatives have by a majority refused to entertain at present any proposal for a new and much-needed survey of that state. We referred to the matter about a year ago, when everything promised well (vol. xi. pp. 381, 497). We can only hope that the present unpatriotic mood of the Legislature will not last long.

ON Monday and Tuesday-week the first Annual Meeting of the Cumberland Association for the Advancement of Literature and Science was held at Whitehaven, when an instructive inaugural address was given by the Bishop of Carlisle, the President of the Association. Other interesting papers were read and excursions made, including a geological excursion along the coast under the guidance of Mr. J. C. Ward, and others. Accounts of some of the confederated societies were given, and altogether this first meeting of the Association promises well for its future and for the cause of culture in Cumberland.

THE Cape of Good Hope University has decided to throw open unreservedly degrees, honours, and pecuniary emoluments at the disposal of that body to candidates who desire to be examined in places beyond the bounds of the Cape Colony, provided the Government of the Colony or the State in which such candidates reside shall be annual contributors of 200*l.* to the funds of the University.

DR. M. T. MASTERS has been experimenting on the functions of the nectaries formed by the small cup-shaped petals of *Helleborus*, and finds that they absorb or digest nitrogenous substances, repeating in all respects the phenomena of the leaves of *Drosera* and *Dionæa*.

WE have received from Prof. Sachs a reply to Reinke's series of papers "Untersuchungen über Wachsthum" in the "Botanische Zeitung" challenging the correctness of experiments made in Prof. Sachs's laboratory at Würzburg on the rate of growth of plants; also a lecture on the "Nourishment of Plants," giving a popular account of the state of our knowledge respecting the phenomena of plant-life.

M. VOGEL, of Munich, has observed, says the *Belgique Horticole*, that seeds germinate much more quickly when watered with water containing camphor than with pure water.

THE Rev. S. J. Perry, F.R.S., has reprinted, in a separate form, his "Notes of a Voyage to Kerguelen Island to observe the Transit of Venus," from the *Month*. These Notes refer not only to the immediate object of the expedition, but describe in a pleasant way the voyage out and the nature of the desolate island which was the home of the various expeditions for many weeks. Many, besides astronomers, will find the narrative interesting and instructive. H. S. King and Co., are the publishers.

FROM Prof. O. C. Marsh we have received a paper on the principal characters of the Brontotheridæ (Titanotheridæ of Flower, NATURE, vol. xiii. p. 327), in which several additions are made to our knowledge of the group. Four genera are described, differing in the number of the always feebly developed incisor teeth. The brain-case is shown to have been small. The toes were the same in number as in the existing Tapirs, four in front and three behind. All the known remains of these animals are from east of the Rocky Mountains, in the Miocene beds of Dakota, Nebraska, Wyoming, and Colorado. Figures of the skull, teeth, brain cavity, and feet, accompany the description.

THE additions to the Zoological Society's Gardens during the past week include three Brown Howlers (*Mycetes fuscus*) from New Granada, a Brazilian Tree Porcupine (*Cercolabes prehensilis*) from South America, deposited; two Leopards (juv.) (*Felis pardus*) from India, presented by Mr. George Beale Brown, 1st W.I. Regiment; a Grey Ichneumon (*Herpestes griseus*) from India, presented by Mr. W. H. Worth; five Water Ouzels (*Cinclus aquaticus*), European, presented by Mr. Frederick Swabey; a Black-headed Gull (*Larus ridibundus*), a Herring Gull (*Larus argentatus*), European, presented by Mr. Brazenor; a Collection of Marine Fishes from the British Seas, presented by Dr. A. H. Smee; five Common Rabbits (*Lepus cuniculus*), European, deposited by Master B. Sclater; a Hoffmann's Sloth (*Cholopus hoffmanni*) from Panama, purchased; twenty Land Crabs from the Ascension, presented by Mr. Win Drew.

SCIENTIFIC SERIALS

THE *Quarterly Journal of Microscopical Science* contains several papers of importance. The first is by Dr. Klein, entitled "Observations on the Early Development of the Common Trout (*Salmo fario*)," in which the condition of the blastoderm between the third and thirteenth day is described. The subject is minutely treated, and the bibliography is very complete.—Mr. John Priestley gives a *résumé* of recent researches on the nuclei of animal and vegetable cells, and especially of ova, and afterwards collates the various statements, indicating their points of divergence.—The investigations of Prof. E. Auerbach and Strasburger, of Dr. Oscar Hertwig and Van Beneden, are those discussed.—M. Edouard Van Beneden's valuable "Contributions to the History of the Germinal Vesicle, and of the first Embryonic Nucleus" contains much of special interest with reference to the relation of the germinal vesicle and the first cleavage nucleus of the egg, especially with reference to the different results arrived at by the author in his study of the ovum of the rabbit, and M. Hertwig's investigations on the echinoderm *Toxopneustes lividus*.—Mr. H. R. Octavius Sankey gives a new method for examining the structure of the brain, and reviews some points in the histology of the cerebellum. The dye employed for the staining is aniline blue-black, in which sections of fresh brain should remain twelve hours or so, and afterwards be dried.—Dr. James Foulis gives a lengthy memoir on the development of the ova and structure of the ovary in man and other mammalia. Three plates accompany his paper. The author mainly devotes himself in this communication to the description of the appearances in the ovaries of young kittens, and of the human fœtus, with the object of demonstrating, in particular, that whereas the eggs are derived from the germ epithelium, the nutrient cells of the ovum, or the follicular epithelial cells, are derived from the cells of the stroma of the ovary.—Dr. Carpenter, in a paper on the genus *Astrorhiza* of Sandahl, lately described as *Haeckelina*, by Dr. Bessels, reintroduces the earlier account of the genus, and figures it.

Journal of Botany.—Among the more important articles on descriptive and systematic botany in this periodical since the commencement of the current year are a description of *Rumex rupestris*, Le Gall, as a British plant, by Dr. Trimen, with a plate; a description of four new species of Fuchsia from South America, by Mr. Hemsley, and a conspectus of the genus *Glycosmis*, by Mr. Kurz, with two plates. Mr. Sorby contributes a paper on the colouring matter associated with chlorophyll, in which he combats some of the conclusions of Pringsheim, and Prof. Church some further notes on plant-chemistry, with analyses of *Lactuca sativa*, *Chondrus crispus*, in which the ash reaches the very large amount of 14·15 per cent. of the air-dry plant, and *Nasturtium officinale*, and of the ash of the bud-scales of the beech, and of the female flowers of the elm. In the April number is the commencement of Prof. De Bary's very important report of researches into the nature of the potato-fungus, *Phytophthora infestans*.

Although the articles in the *Scottish Naturalist* are mainly of local interest, two notable exceptions are furnished by those on "Animal Psychosis," by the Rev. J. Wardrop, and "Illustrations of Animal Reason," by Dr. Lauder Lindsay, portions of which occur in the numbers for January and April, both of which we hope to see reprinted in a form to reach a larger public. There are a large number of notes on the zoology of Scotland, and Mr. A. Sturrock records an addition to the flora of that country in the discovery, in Loch Cluny, Perthshire, of *Naias flexilis*, hitherto confined to Ireland as far as the British Islands are concerned. Dr. Buchanan White and Dr. Sharp continue their lists of the Lepidoptera and Coleoptera of Scotland respectively.

Poggendorff's Annalen der Physik und Chemie, No. 1, 1876.—In Regnault's experiments on the specific heat of gases, it was necessary that the spiral through which the gas streamed should have considerable length, so that the gas might fully take the temperature of the heating vessel, and fully yield up its heat in the calorimeter. A correspondingly large size of vessel and a large quantity of gas were required. In a new investigation by M. Wiedemann, here described, the chief object was to diminish the calorimeter, and yet not compromise the yield of heat of the gas, that is, to afford the heated gas as great a surface in as small a space as possible. His heating vessel was a copper cylinder stuffed with copper turnings and enclosed in another copper vessel containing water or paraffin to be heated. In the calorimeter the gas passed successively through three vertical and connected silver pipes filled with silver turnings, and gave its heat to the surrounding liquid. The author shows that his method is not behind that of Regnault in accuracy, and as the quantity of water was only a tenth of that which Regnault used, only a tenth part of the gas was required, to obtain as great elevation of temperature. Thus extensive results could be had in shorter time. The tabulated numbers for the seven gases examined do not materially differ from those of Regnault.—A paper by Dr. Dvorak follows, describing many interesting experiments on acoustic attraction and repulsion. He studies the case of rods in transverse vibration; also the action of a screen in a sound wave; acoustic attraction and repulsion of resonance; also that in liquids and the phenomena in air columns thrown into continuous vibrations.—The observations of M. Plateau on liquid films are extended by Dr. Sondhauss, who endeavoured to determine the extent to which different liquids could be stretched in films in wire rings, observed such lamellæ in closed vessels excluding external disturbances, measured with a balance their tension, and, with a manometer, the pressure of bubbles on the enclosed air; he also measured the weight of such lamellæ and bubbles, whence their thickness might be inferred. With a simple contrivance, consisting of a thin wire bent horizontally to an angle and a straight wire placed across and drawn gradually away from the angle, it may be shown that all liquids can be stretched in lamellæ, and different liquids may be compared in this respect. But Dr. Sondhauss prefers the circular wire rings. He compares (as to size) the films got from forty-six different liquids. Among some facts relating to durability of films, we note that one film from a guillaja decoction, to which a little glycerine had been added, was produced in a vessel on 1st Sept., 1872, and lasted till 11th March, 1873 or over half a year.—M. Groth communicates the results of a study of the elasticity of rock salt by observation of the velocity of sound in different directions in it, a method more easily carried out than that of M. Voigt, who measured the elastic bending of rods of the substance. The researches of both leave no doubt that in regular crystals the coefficient of elasticity, and therewith the velocity of sound, is a function of the direction; and in accordance with Neumann's theory, they vary symmetrically with reference to the planes of symmetry of the crystal. A geometrical plane of symmetry of a crystal is at the same time a physical plane of symmetry. A crystal may be defined as a homogeneous solid body whose elasticity varies with the direction.—We further note the first part of a valuable paper by M. Grotrian, on the constants of friction of some salt solutions and their relations to galvanic conductivity; and some observations of M. Edlund on the connection of galvanic induction with electro-dynamic phenomena; also, extracted papers on the occurrence of nitrogenous iron among the fumarole products of Mount Etna, and on the thermo-electric properties of some calcareous spar, beryll, idocrase, and apophyllite.

Revue des Sciences Naturelles, December, 1875.—The most interesting original observations recorded in this number are contained in a short paper by D. A. Godron, on fertilisation of flowers by Hymenoptera. Near Nancy it is found that the hybrid produced by the fertilisation of *Primula grandiflora* with pollen of *P. officinalis* results from the intervention of bees, but the converse hybrid does not occur. M. Godron published an account of this in 1844. The reason for the non-occurrence of the second hybrid is that *P. grandiflora* flowers earlier in this locality than *P. officinalis*. M. Godron was able to produce the hybrid *P. grandiflora-officinalis* artificially, but never saw it as a natural product till March, 1874, when it was brought to him from a locality two kilometres distant from the first. On investigation it was found that only *P. officinalis* grew at this spot, and that owing to situation and surroundings it flowered much earlier than in the other locality; but the hybridisation could only be effected by the carrying of the pollen of *P. grandiflora* two kilometres by bees.—The summaries of French memoirs on science are full and valuable; foreign summaries of moderate extent are likewise given.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 4.—"On the Absorption-Spectra of Bromine and Iodine Monochloride," by H. E. Roscoe, F.R.S., and T. E Thorpe.

The paper contains the results of an exact series of measurements of the absorption-spectra of the vapours of the element bromine and of the compound iodine monochloride, made with the object of ascertaining whether the molecules of these two gases vibrate identically or similarly, their molecular weights and colour of the vapours being almost identical.

A careful comparison of these Tables and of the map shows that, although both spectra contain a large number of lines which are nearly coincident, the spectra as a whole are not identical, either when the vapours are examined at high or low temperatures, or when the length of the columns of absorbing gas are varied.

Linnean Society, April 20.—G. Bentham, F.R.S., vice-president, in the chair.—Mr. Hudson, Dr. Prior, Mr. Stainton, and Mr. C. Stewart were appointed auditors for the current year.—Dr. Hooker, P.R.S., exhibited some specimens illustrating a communication from Dr. J. Kirk, which was read. This latter referred to the identification of the modern copal tree, *Trachylobium Hornemannianum*, with that which yielded the Zanzibar Copal or Gum Animi, now found in the earth on the east coast of Africa, and often where no copal yielding tree now exists. Little doubt now rests as to the identity of the semi-fossil with the living tree, inasmuch as bijugate leaf, flower-bud, flower, ovary and stamens, characteristic of the latter have been discovered in the so-called Animi. Dr. Kirk is inclined to account for their difference in quality by a molecular or chemical change in the buried material; improving it thereby, and as a consequence increasing its market value.—Mr. W. P. Hiern read a paper "On the African species of the genus *Coffea*, Linn." As at present understood this genus belongs to the Old World, and the numerous American species that have previously been referred to it, now find places in other genera. All the species most valuable for economic or commercial purposes are confined to Africa or are of African origin. Of the seven Indian species, one formerly was cultivated, but from its inferiority has since been discarded in favour of the African plants. The so-called wild coffee of Sierra Leone and Fernando Po, and other berries, are occasionally used by the inhabitants of those places as coffee; but they do not belong to the genus in question. The author distinguishes and technically characterises some fifteen species of coffee plant as indigenous to Africa and its adjacent islands. They are:—1. *C. arabica*, 2. *C. liberica*, 3. *C. stenophylla*, 4. *C. zanguebariæ*, 5. *C. brevipes*, 6. *C. melanocarpa*, 7. *C. mauritiana*, 8. *C. Macrocarpa*, 9. *C. hypoglauca*, 10. *C. microcarpa*, 11. *C. afzelii*, 12. *C. subcordata*, 13. *C. rupestris*, 14. *C. jasminoides*, 15. *C. racemosa*. He rejects some six supposed species of African Coffees, showing these belong to other groups. Of the 15 species, 13 inhabit the African Continent, and 2 pertain to Mauritius and Bourbon; so far as yet explored, West Africa furnishes 11 species, and but two are found in East and Central Africa. Mr. Hiern describes numbers 2, 5, 11, 12, and 13, viz., five in all as new species, and three others are MS. names of specimens in the herbarium of the late distinguished botanist, Mr. Welwitsch. He alludes to a pale-berried variety of the *C. arabica* found by Vogel in Sierra Leone. By far the most interesting new plant commercially and otherwise is the Liberian Coffee introduced into this country in 1874, by Mr. W. Bull, the horticulturist. This is said to be far superior to the ordinary coffee of commerce, *C. arabica* having larger berries, a finer flavour, and being at the same time more robust and productive.—A paper "On the Classification of *Narcissus*," by Mr. Shirley Hibberd, was announced.—Mr. Thiselton Dyer read a note "On the Plant yielding Lattakia Tobacco," and exhibited specimens corroborating the conclusions arrived at by him. These latter are that Lattakia tobacco is produced by a different species to the Turkish, and that as imported into this country it consists of the flowering twigs made up into bundles which have been smoked with pine wood.—Prof. Dickie had a summary read of a further contribution of his to the botany of the *Challenger* expedition, viz., a List with Remarks of the Polynesian Algæ collected by Mr. Mosley. Only a very few species appear to be new to science.—Dr. Hooker communicated a paper of P. F. Reinsch's, on New Freshwater Algæ obtained by the Venus Transit Expedition in the Island of Kerguelen. This being technical in character, was taken as read.

Chemical Society, May 4.—Dr. Gilbert, vice-president, in the chair.—Eight communications were made to the Society, namely:—On glycero-phosphoric acid and its salts as obtained from the phosphorised constituents of the brain, by Dr. J. L. W. Thudicum and Mr. C. T. Kingsett.—On some reactions of biliverdin, by Dr. Thudicum.—On the relation between chemical constitution and colouring power in aromatic substances, by Dr. O. Witt.—On certain bismuth compounds, by Mr. M. M. P. Muir.—A new method for preparing the hydrocarbons diphenyl and isodinaphthyl and on the action at a high temperature of metallic chlorides on certain hydrocarbons, and a note on the occurrence of benzene in rosin light oils, both by Mr. W. Smyth.—On the action of water and of various saline solutions on copper, by Mr. T. Carnelly, and notes on some experiments made to ascertain the value of a proposed method of determining the mineral strength of soils by means of water culture, by Mr. G. W. Hight.

Zoological Society, May 2.—Robert Hudson, F.R.S., vice-president, in the chair.—Mr. G. Dawson Rowley exhibited and made remarks on a specimen of *Machærirhynchus nigripectus*, from New Guinea, believed to be the first example of this rare bird which had reached this country.—Extracts were read from several letters received from Dr. George Bennett, F.Z.S., giving some account of the proceedings of Mr. L. M. D'Albertis, and of his recent expedition up the Fly River in December, 1875.—Mr. J. H. Gurney, jun., exhibited and made remarks on an example of the Lesser White-fronted Goose, from Egypt, being the first record of the occurrence of this species in Africa.—Mr. Osbert Salvin, F.R.S., exhibited and made remarks on a piece of a trunk of a pine from Guatemala, which had been perforated by a Woodpecker (*Melanerpes formicivorus*), for the purpose of storing acorns.—Mr. A. Grote exhibited and made remarks on Col. Gordon's drawing of *Ovis polii*, which was the original of the figure given in the Society's *Proceedings* for 1874.—Mr. George Busk, F.R.S., read a memoir on the Ancient or Quaternary Fauna of Gibraltar, as exemplified in the Mammalian remains of the ossiferous breccia, which occurs in the caves and fissures recently explored in different parts of the rock.—Mr. Busk, after a preliminary description of the geological features of the rock and its fossiliferous caverns and fissures, treated specially of the various bones of the bear, cat, horse, rhinoceros, stag, ibex, and other animals, of which the remains occur there, and proceeded to refer them to the species to which they seemed to belong.—Prof. A. H. Garrod read a paper on the anatomy of the Colies (*Colius*), which he regarded as belonging to the Piciform group of the division of Anomalogonatous birds according to his arrangement, but constituting an independent family.—A communication was read from Mr. E. L. Layard, containing the description of a new Blackbird (*Turdus*), from Taviuni, one of the Fiji Islands.—The Rev. Canon Tristram read a note on the occurrence of the Roebuck in Palestine.

Geological Society, April 26.—Prof. P. Martin Duncan, F.R.S., president, in the chair.—The Rev. Edwin Hill, M.A., was elected a Fellow, and Prof. Beyrich, of Berlin, a Foreign member of the society. The following communications were read: A translation of the notice by Capt. Miaulis of the Greek royal navy, of the occurrence of a submarine crater within the Harbour of Karavossera, in the Gulf of Arta. Communicated by the Secretary of State for Foreign Affairs.—"The physical history of the Dee, Wales," by Prof. A. C. Ramsay, F.R.S. The author stated that he regarded the valley of the Dee as mainly preglacial throughout, and sketched the physical history of the region through which it runs. The silurian rocks were much disturbed and denuded before and during the Carboniferous period, and the carboniferous limestone was deposited very unconformably on the upturned edges of both lower and upper silurian strata, and once spread all over the region, probably overlaid by the millstone grit and coal-measures, as now in the east of Denbighshire and Flintshire. The region was again disturbed and elevated during the formation of the Permian deposits, and then by sub-aërial denudation a great part of the carboniferous series was removed down to the old plain of denudation of the Silurian rocks, the surface of which thus probably stood higher than it does at present, being in the midst of a broad continental area. From a consideration of the conditions of deposition of the Mesozoic and Tertiary formations the author concluded that, from the beginning of the Permian to that of the Glacial epoch, the higher ground of Wales was land well raised above the sea, except perhaps during the deposition of the chalk, and that during all this period it was exposed to the influence of sub-aërial agents of denudation. He indicated the conditions of elevation of the old table-land of carboniferous rocks, and showed that it had probably a slope towards the east and north-east to the extent of about 23 feet in a mile. The drainage of this land then flowed in an easterly and north-easterly direction

along the earliest channel of the Dee, which would be at an elevation from 1,300 to 1,400 feet higher than the present channel. During the Glacial epoch ice-action deepened, and more or less modified the existing channel, and scooped out the basin of Bala Lake, which was not previously in existence. The general results of this investigation are as follows:—After the last important disturbance of the pre-Permian rocks, North Wales was carved slowly and by sub-aërial agencies into its present mountainous form, chiefly between Permian and Preglacial times. The work of the glaciers of the latter period somewhat deepened, widened, smoothed, and striated the minor outlines of the mountains and valleys, and excavated many rock-bound lake-basins, but did not effect any great changes in the contours of the country. A minor submergence of part of Britain during part of the Glacial epoch produced no important effects on the large outlines of the rocky scenery; and the effects of sub-aërial waste subsequent to the Glacial epoch have been comparatively small.—On the Ancient Volcano of the District of Schemnitz, Hungary, by Mr. John W. Judd. The old volcanoes of Hungary have long been known to present some very interesting illustrations of the relations between the igneous rocks erupted at the surface, and those which have consolidated at a considerable depth beneath it. The district in which these phenomena can be best studied is that of Schemnitz; but although this area has been very carefully mapped and explored by a number of able investigators, the greatest diversities of opinion still exist concerning the relations of certain of the rock-masses exposed within it. Over an area nearly fifty miles in diameter enormous accumulations of *ändesite* and *quartz-ändesite* lavas and agglomerates have been erupted, these now forming a group of mountains rising from 3,000 to 4,000 feet above the sea-level, and culminating in a great ring of precipitous heights overlooking a depressed central area of oval form, the site of the famous mining towns of Schemnitz, Kremnitz, and Königsberg. In the midst of this depressed central area there occurs a considerable development of *rhyolitic* lavas and tuffs, and more scattered outbursts of *basalt*. From the magnificent floras associated with the various volcanic tuffs, we know that the andesitic rocks were erupted during the earlier portion of the Upper Miocene period and the rhyolitic towards its close, while the basalts are probably of as late date as the Pliocene. Besides the rhyolites and basalts, however, there are certain other rocks exposed in the central area of the Schemnitz district, the relations of which it is very difficult to understand. These consist of (1) strata of Lower Trias and Nummulitic age, through the midst of which the volcanic outbursts have evidently taken place; (2) masses of highly metamorphic rocks, including quartzites, crystalline limestones, various schists, gneiss and aplite; and (3) undoubted eruptive rocks, which have usually been called "syenite and granite," but for which the names of "diorite and quartz-diorite" would perhaps be more appropriate, inasmuch as the prevailing felspar in them is always a plagioclase variety. By Beudant and other early writers the andesitic lavas were recognised as volcanic products of a comparatively recent geological period, while the "granite, syenite, and greenstone," were regarded as being of far more ancient date. By von Pettko, Richthofen, and all the more recent investigators of the district, however, it has been clearly perceived that the "greenstones" are certainly, like the andesites, of Tertiary age, and hence such names as "greenstone-trachyte" and "propylite" have been applied to them. The studies of the author of the present memoir, both in the field and in the cabinet, have led him to the conclusion that the granitic, porphyritic, and lava rocks—which were formerly called "syenite," "greenstone," and "trachyte" respectively—*are all of similar composition and equivalent age*, and that they differ only in their more or less perfect state of crystallisation, the result evidently of variations in the conditions under which they have consolidated. He is further led to regard the metamorphic masses, around the several intrusive centres as being not, as has hitherto been maintained, of "Primary" (Devonian or Permian) age, but simply Triassic rocks affected by local or contact metamorphism. The real structure of the great Schemnitz volcano was first recognised by von Pettko in 1848, though this author erroneously regarded it as presenting an example of a "crater of elevation." The history of the formation and destruction of this volcano is now shown to be as follows:—After some small and scattered outbursts of rocks of acid composition towards the close of the Oligocene period, the grand eruptions of andesitic lavas of the Miocene began, through the agency of which a volcano of larger dimensions than Etna was gradually built up, by both central and lateral eruptions. In the midst of this volcano a crater of enormous dimensions was formed, doubtless by some great paroxysmal outbreak, and by the subsequent subsidence of the mountain the sea gained access to, and by denudation greatly enlarged the area of this "Caldera." Then in the central lagoon of the caldera a number of minor eruptions, first of acid and then of basic rocks took place; and the volcano, which at this period of its history must have closely resembled the existing island of Santorin, was again upheaved from beneath the sea, and exposed to the wasting effects of subaerial denudation. The gradual decline of the volcanic forces in the district was marked, as is usually the case, by the appearance of hot and mineral springs, discharges of gas, occasional earthquakes, &c. While affording such remarkable examples of the perfect transition between the so-called plutonic and the volcanic classes of rocks, and of the phenomena of contact metamorphism, the granitic masses of the Schemnitz district are without question truly *intrusive*; and a careful study of them lends no support whatever to the hypothesis that such rocks may be formed by the extreme metamorphism of sediments *in situ*. There is the most complete proof that in the Schemnitz district the formation of true mineral veins, containing gold, silver, and other metals, has taken place within the most recent geological periods; in some cases, indeed, at a later date than the Pliocene.

Institution of Civil Engineers, April 25.—The first paper read was descriptive of the "Dhu Heartach Lighthouse," by Mr. David Alan Stevenson, B.Sc.—The second paper read was "On the changes in the tidal portion of the river Mersey, and in its Estuary," by Mr. James N. Shoolbred, B.A., Assoc. Inst., C.E.

May 2.—Mr. George Robert Stephenson, president, in the chair.—The paper read was on fascine work at the outfalls of the Fen Rivers, and reclamation of the foreshore, by Mr. W. H. Wheeler, M. Inst. C.E.

Berlin

German Chemical Society, Feb. 28.—A. W. Hofmann, president, in the chair.—H. Ritthausen described a crystalline constituent of vicia saliva vicin, $C_8H_{16}N_3O_6$, which, treated with sulphuric acid, yields a sulphoconjugated acid, exhibiting blue reactions with baryta water and ammonia.—R. Schiff has transformed chloraechyl-aldehyde by heating it with acetate of potassium into the diacetate of ethylidene. The former body is therefore chlori-acetate of ethylidene,

$$CH_3—CH.Cl—O—CO—CH_3.$$

—R. Barth, by treating resorcine with hydrochloric acid, has produced an anhydride of resorcine, $C_6H_4OH.O.C_6H_4OH$, a dichroic substance, green in reflected light and red in solution.—O. Wilf published considerations on the constitution of organic dyes.—M. Nencky has found indigo in the urine of dogs fed with indol.—A. Oppenheim reported on various researches on aceto-acetic ether. Together with H. Precht, he has simplified the method for obtaining this substance in large quantities. The vapour density has been taken, and it has been explained why no hydrogen is evolved during the action of sodium on acetic ether; the reason being the transformation of acetyl, CH_3CO, into oxethyl, CH_3CH_2O. The same chemists have discovered a practical method for obtaining dehydracetic acid, $C_8H_8O_4$, by passing aceto-acetic ether through heated iron tubes. They described its ethyl-compound and the action of potash on dehydracetic acid: $C_8H_8O_4 + 3H_2O = 2C_2H_4O_2$ (acetic acid) + C_3H_6O (acetone) + CO_2. Baryta forms at the same time a substance resembling orcine. The same chemists found acetic ether, when heated, to yield ethylene and acetic acid.—A. Oppenheim and C. Emmerling have studied the action of oxydising agents on oxyuritic acid. The result is an acid, $C_7H_8O_3$, to which they give the name of hydro-oxybenzoic acid. By fusion with potash, it yields benzoic acid and water.

March 13.—A. W. Hofmann, president, in the chair.—Dr. Radziszewsky has transformed phenylacetic acid

$$C_6H_5 . CH_2 . COOH$$

into the corresponding aldehyde and alcohol; phenyl-ethyl-alcohol $C_6H_5 . CH_2 . CH_2OH$, liquids boiling at 207° and 212°.—F. Salomon has compared the properties of oxalurate of ethyl obtained by synthesis from urea with chloro-oxalate of ethyl with that obtained from oxalurate of silver. He has found them identical in the properties. Amongst other reactions he remarks that both with oxide of silver yield parabanate of silver.—V. Meyer and several of his pupils revert to the reaction which mixed azocompounds:—

$$\underset{\substack{\text{Nitrate of}\\ \text{diazobenzol.}}}{C_6H_5N_2NO_3} + \underset{\substack{\text{Sodium-}\\ \text{nitro-ethane.}}}{C_2H_4NO_2Na} = NaNO_5 + \underset{\substack{\text{Nitro-ethyl-}\\ \text{azophenyl.}}}{C_6H_5N_2C_2H_4NO_2}$$

By generalising this reaction the following compounds have been prepared :—By V. Meyer : azonitropropylphenyl,

$$C_6H_5N_2C_3H_6NO_2 ;$$

by T. Barbieri : azonitroethylparabolyl, $C_7H_7N_2C_2H_4NO_2$; and azonitrophenylorthobolyl, $C_7H_7N_2C_2H_4NO_2$; by H. Wald : azonitroethylparabromophenyl, $C_6H_4BrN_2C_2H_4NO_2$; by F. Hallmann : azonitroethylnitrophenyl, $C_6H_4NO_2N_2C_2H_4NO_2$.—V. Meyer and M. Lecco described the following reaction :—

$$\underset{\text{Dibromonitropropan.}}{CH_3CH_2CBr_2(NO_2)} + \underset{\text{Hydroxylamine.}}{H_2NOH} = 2HBr +$$

$$\underset{\text{Propylnitrolic acid.}}{CH_3 . CH_2 . C = NOH(NO_2).}$$

—W. Michler described the following reactions :—

$$\underset{\substack{\text{Oxychloride}\\ \text{of carbon.}}}{COCl_2} + \underset{\text{Diphenylamine}}{NH(C_6H_5)_2} = HCl + \underset{\text{New chloride.}}{CO{}^{Cl}_{N(C_6H_5)_2}.}$$

This, with ammonia, yields the urea, $CO(NH_2) . N(C_6H_5)_2$; and with aniline the urea, $CO(NHC_6H_5) . N(C_6H_5)_2$. Oxychloride of carbon and ethylaniline yields the chloride—

$$CO{}^{Cl}_{N(C_6H_5)(C_2H_5).}$$

If, instead of monoethyl-aniline, dimethylaniline is submitted to the action of oxychloride of carbon, the reaction passes in a different manner, namely :—

$$\underset{\text{Dimethylaxiline}}{2N(C_6H_5)(CH_3)_2} + COCl_2 = \underset{\text{Hydrochlorate of dimethylaniline}}{HCl\ N(C_6H_5)(CH_3)_2} +$$

$$\underset{\text{Chloride of dimethylamidobenzoic acid.}}{N(CH_3)_2C_6H_4COCl}$$

The acid is easily obtained, and proves to be identical with dimethylamidoparabenzoic acid.—P. Claessen proved the identity of rhodan-acetic acid of Heintz with what Vollhardt called isosulfocyano-acetic acid.—C. Reimer has obtained the following very remarkable result of the action of chloroform on an alkaline solution of phenol, viz., salicylous acid. This reaction may be generalised. Cresol and other phenols offer similar results.—O. Braun described an apparatus destined to retain the solid and liquid parts of smoke, as also those parts that may be absorbed by solids or liquids. He likewise described a similar apparatus for retaining sparks.—E. Schunk and H. Roemer gave details on the preparation of isoanthraflavinic acid and a comparison of its properties with anthraflavinic acid. The described substitution-derivatives with four atoms of bromine and with two molecules of acetyl, ethyl, and methyl respectively.—F. Tieman has transformed vanilline by acetic anhydride into a coumarine. The corresponding acid is ferulic acid. He drew attention to the relation of vanillinic and coniferylic derivatives which corresponds to that of benzoic and cinnamic compounds.—F. Tiemann and H. Haarmann have found in vanilla besides vanilline, vanillic acid, resin, and fat.

PARIS

Academy of Sciences, May 1.—Vice-Admiral Paris in the chair.—The following papers were read :—Discovery of the small planet (163), M. Leverrier. It was discovered at Toulouse, April 26, by M. Perrotin.—On the electro-motive forces produced on contact, of liquids separated by capillary diaphragms of any nature, by M. Becquerel. Using dilute instead of concentrated liquids, he finds the electromotive force increases with the time of contact reaching a maximum. The action probably consists of a condensation of acid and alkaline particles on the faces of the diaphragm, just as gases are condensed in porous bodies.—On the oscillations of temperature of half January, half February, and half April, 1876, by M. Sainte-Claire-Deville. In April there was a minimum about the 15th; in January and February about the 12th.—On microclinic felspar and on andesine, by M. Sainte-Claire-Deville.—Microscopic examination of orthose and of various triclinic felspars, by M. Des Cloizeaux.—On electric polarisation, by M. Du Moncel. An electrified plate sheathed with oxygen may produce a different effect from an unelectrified plate so sheathed, the electric vibrations continuing after the electric source has ceased (phosphorescence is analogous). The author studies this with hard stones; he also studies the effects of polarisation with induced currents, effects of local currents in stones, &c.—Note on the theory of several hydraulic machines of his invention, by M. De Caligny.—On the embryogeny of Ephemera, especially that of *Palingenia virgo* (Olivier), by M. Joly.—On fishes of the Ceratodus group in the river Fitzroy, Australia, by M. de Castelnau.—New researches on gallium, by M. Lecoq de Boisbaudran.—Experiments on solar heat, by M. Salicis. A sealed packet (of 1868) relating to utilisation of solar heat by reflectors, &c. He describes a heliodynamic and a heliostatic apparatus.—Researches on the compounds of pure carbon in meteorites, by Mr. J. Lawrence Smith.—On the Phylloxera which comes from the winter egg, by M. Boiteau. Direct application of sulphide of carbon in the treatment of phylloxerised vines, by M. Allies.—On a new mode of cultivation of the vine without pruning, by M. Martin.—On the employment of the method of articulation in education of deaf mutes, by M. Houdin.—Observations of planets at the Observatory of Marseilles, by M. Stephan.—Phenomena of interference obtained with thin sheets of collodion, by M. Gripon.—On the distribution of magnetism in cylindrical bars, by M. Bouty.—On the transmission of electric currents by derivation across a river, by M. Bouchotte; an experiment made in 1858. An air line of 300 m. (with battery) on one bank of a river, was connected by both ends to earth, and a similar line on the other bank contained a galvanometer. On the battery circuit being closed, the needle was deflected.—On a new system of electro-magnet with flat spirals, by M. Serrin. The wires of bobbins of electro-magnets, used in regulators of powerful electric lights, sometimes become so hot as to fuse the insulating matter surrounding them. M. Serrin forms his electro-magnetic spirals of metallic helices without insulating cover, and so arranged that the spirals cannot touch one another. He hollows out his helice from a copper cylinder of thickness equal to that of the bottom, and he covers the core with vitreous enamel. The spiral may be raised to a red heat without the sensibility of the apparatus being affected.—On a new sulphate of potassium, by M. Ogier.—On the origin of stripe in puddled iron, by M. Le Chatelier. The stripe results from small fusibility of partially peroxidised scoriæ, and from the comparatively low temperature at which the puddling is done.—On a new crystallised organic substance, by M. Loiseau. It is called *raffinose*, and was got in investigating the most favourable conditions for extraction of sugar from molasses by means of the sucrate of hydrocarbonate of lime. Crystalline raffinose has the formula $C_6H_7O_7$.—On a new method of studying the respiration of aquatic animals, by MM. Jolyet and Régnard. The object is to keep the medium always in the normal state, however long the experiment. In a limited closed space, containing determinate quantities of water and air, it was required to make air circulate in the water, to absorb the CO_2 in proportion as it was exhaled, and replace O as it was consumed. A figure of the apparatus is given.—On the crystalline system of various substances presenting optical anomalies, by M. Mallard.—The elephants of Mont Dol; dentition of the mammoth; distinction of upper and lower molars, right and left, by M. Sirodot.—On the cranial cavity and the position of the optic orifice in *Steneosaurus Heberti*, by M. Morel de Glasville.—On a new thermo-cautery, by M. Paquelin. It depends on the property which platinum has, of becoming incandescent (once it has been raised to a certain degree of heat) in a gaseous mixture of air and of certain hydrocarbonised vapours.

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